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EVIDENCES OF A REVIVAL IN BUSINESS.

AS REFLECTED IN THE NEW YORK MARKETS.

THE seventh volume of THE ENGINEERING MAGAZINE opened, in April last, with a leading paper on "The Outlook for an Improvement in Business," consisting in part of a forecast which has been so strikingly verified that it seems proper, at the threshold of the eighth volume of the Magazine,—which happens, fortunately, at a period of quickening of business,—to refer both to the subject and to the article itself. The writer of this paper expressed the belief that, "after the long siege of depression and general financial and commercial demoralization we have had in the United States, the turning-point has finally been reached." It was mentioned as a hopeful sign that "there has rarely been a time when the outstanding obligations of merchants were so small," besides which reference was made to the plentiful supply of money and the greatly increased wealth of the United States within recent years. As for the then pending legislation at Washington, the writer said: "With the settlement of the tariff question the merchants will soon adjust themselves to the new conditions, and business must necessarily drift back to its normal state." Going more into detail, the article continued:

> There was no fall trade last year and the delay in legislation at Washington has killed the spring trade. The people are now anxiously looking forward to the crop period; and if the harvest is up to the average and we have a good foreign demand, as it is fair to think that we will have under existing low prices, the entire purchasing power of all our crops for this year will come against a greatly diminished supply in each and every branch of manufacture. With a people so easily stimulated, so ambitious, and so enterprising as Americans are proverbially known to be the world over, it must be apparent to any thoughtful mind that the stimulation which the marketing of the crops will produce throughout all lines of industry and commerce must restore confidence with a swing; and as a result we may reasonably look for a speedier revival next fall than a long period of depression under other circumstances would permit us to hope for.

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The writer of the above paper, Mr. J. Edward Simmons, president of the Fourth National Bank of New York, when asked to favor the readers of the Magazine with his views on the business situation at the present time, did so in the following words:

"The business outlook has shown decided improvement of late. This has been shown, first, in the recent very heavy sales of merchandise, particularly of dry-goods, the transactions in which have been of unusual volume for the season. The railways have not yet reflected the general improvement, but they will begin to do so with the transportation of the merchandise I have referred to. Very soon the crops will begin to move toward the markets, and they are unusually heavy this year, promising employment for a vast deal of railway equipment. It has been reported that a great shortage exists in the corn crop in the west, but this, I am convinced, has been exaggerated. The crops in the south are very heavy this year, the cotton crop being, perhaps, the largest known. But in addition to this, other crops are now being produced in the south in greater volume than formerly.

"The promise for the near future from all these conditions is good—very good. There is not to be expected any 'boom' in business, but there will be slow and steady improvement. It will be enhanced when England has time to be heard from—when she begins to buy back some of the securities which were unloaded on us in the early days of our late period of depression. It must be remembered that during all of the panic we have not lost any of our existing wealth. At one time a scare prevailed lest our currency should be found on a silver basis, but no reason for such fear any longer exists; on the other hand, the country is on a par with all the great gold-paying nations of the earth. It must be admitted, however, that the purchasing power of the people has not yet returned to the normal standard, but it is rapidly doing so. Wages are on a lower scale now than three years ago, but with the possible exception of rent, every item of living expense has been reduced. A dollar to-day, or perhaps a dollar and a half, will buy as much of the necessaries of life as two dollars would buy a short time ago. In addition to the above considerations, I may add, as having a bearing upon the situation, that in the banking world money is very easy."

NEXT to the banking houses, nowhere else is the effect of good times or the opposite more promptly reflected than in the dry-goods district of New York. Here are stored fabrics which will help to clothe every family—almost every individual—in the United States. Hither come buyers from every state, from city, village, and hamlet—for in these days of cheap travel merchants of every degree come to the

metropolis to replenish their stocks. Immediately following the passage of the tariff bill the signs of activity in the dry-goods trade were apparent to all. The custom-house forces were busy with the release of imports which had been delayed until they could be admitted under lower rates of duty; the hotels were filled to overflowing with buyers of goods; and the sidewalks were next to impassable with the packages of merchandise awaiting distribution over the country. Views of the situation have been obtained for the Magazine from two representative wholesale dry-goods houses.

The first is from the house of the H. B. Claflin Company: "There is a large number of buyers of dry-goods in this city at this time—far larger than last year at the same date. They began arriving almost at once after the disposal of the tariff bill at Washington. They have come from various parts of the country, but mainly from the South and from the states adjacent to New York, for the reason that the principal cities of the west have become important centers for the dry-goods jobbing trade. The number of buyers visiting this city from year to year is subject to no known rule; for instance, many dry-goods merchants from Texas may come to New York in one year while in the next they may all stop to buy in St. Louis. Large out-of-town stores are apt to have resident buyers in New York, whose orders are being handed in all the time. But that buyers have come to us this season in good numbers we know. We also know that stocks have reached a low point in stores throughout the country, so that replenishing now is an absolute necessity. To say that the present buying is the beginning of a period of continued business activity would of course be mere guesswork, but we believe that a turning-point has been reached in the depressed condition of the trade, and that better times are at hand. Collections have been very good of late, although it is too early for the returns from the new crops to have gotten into circulation."

The second statement is from Mr. George C. Clark, of the firm of Tefft, Weller & Co: "The number of dry-goods buyers in the city is much larger than at this time last year, though smaller than in 1892, which was an exceptionally good business year. They have been coming from every part of the country, some of them living as far west as California. The fact is becoming realized that New York is, after all, the place to buy goods, though western jobbing centers will always get a share of the trade. The merchants who have come to town are buying freely, but carefully, in a way which indicates that their stocks have become greatly depleted, and that buying now is a necessity if they are to continue in business. Beyond the condition for the moment there is nothing about which we can be certain. But many of the causes which have interfered with trade for some time past have

disappeared, and there is nothing now in prospect to further depress business. The agitation at Washington of the silver question was an obstacle to trade while it lasted, but the moment that subject was disposed of there was a marked improvement. Next came the discussion of the tariff, which is also disposed of for the time, much to the relief of business. The new tariff law is not all that we could have asked, but anything in the way of reforming the tariff is better than nothing, and, more than all, it is important to have uncertainties removed. As for prices, the future has already been discounted. Thus woolen goods on which reduced duties go into effect on January 1 are being sold now at prices based upon the new schedule of duties. But there is one element in the business depression of 1893 which has not received, publicly, the attention it deserves. I mean the effect of the World's Fair upon the purchasing power of the masses. Most of the people who went to Chicago last year did not have surplus money enough to defray the expenses of the trip, in consequence of which their bills at the stores remained unpaid, and merchants were unable to buy new goods for the fall and winter trade. I have seen examples of the effect of this factor in last year's trade in several parts of the country, and am satisfied that the effects were very widespread. The trade has been recovering from these effects, however; local collections, though delayed, have been made, and out-of-town merchants have been reducing their obligations. Collections are now very, very good in this market."

SEPTEMBER is also the opening of the season in the great grocery distributing trade, of which New York is the headquarters. In this line it was learned from Messrs. Francis H. Leggett & Co.: "The wholesale grocery trade, for which this is the opening of the busy season, is much more active now than at the opening last year. The number of buyers visiting the city and the number of orders coming by mail are encouraging, but it is too early to institute comparisons with former years that will be of value. The handling of imported goods is a large branch of the business of our house, and there has not been time, since the going into effect of the new tariff law, for our trade to become adjusted to the new rates of duty. The ending of the discussion on this subject has given a stimulus to trade. People do not care always so much about what they have to pay as they do about buying on a certainty; they hesitate to engage to pay 15 cents a pound for an article which, a little later, might be bought for 14½ cents. Hence the benefit to us of getting the tariff discussion out of the trade. We believe that the condition of business over the country is improving.

MR. C. A. MOORE, of Manning, Maxwell & Moore, extensively engaged in the machinery business, said of the situation: "While there are evidences of returning business activity, the improvement cannot be said to have reached our particular line. The machinery industry is about the first thing to feel the effects of a business depression, and the last to recover. The trade in articles of daily consumption responds most readily to fluctuations in business conditions; clothing is in demand, changing with the seasons, very much in the same volume, year by year; but important sales of machinery must await the starting of new enterprises, or considerable additions to old ones, involving the investment of new capital, and that, in turn, is dependent upon good business prospects and a settled feeling of confidence. Without doubt the business of manufacturing has been overdone in this country; at least some marked successes in this business induced many persons to go into it within recent years who ought never to have done so, and who met with disastrous results. Almost everything has been on a basis of too much inflation. The whole country was in the position of an individual living beyond his means, without realizing the fact, when the Baring failure occurred. Our business depression has not been confined to the United States, by any means, but local causes have contributed to it, and in the minds of many people bear the blame for the whole trouble. For more than a year the eyes of our people have been too much upon Washington, where both the Sherman-law repeal and the revision of the tariff occupied more time than was anticipated, during which period the people had their minds distracted from business, and industries came to a standstill. The end has been reached in this respect, however, and meanwhile a course of general liquidation has been in progress, and a gradual but slow revival of business may be expected as confidence is reëstablished."

RESPECTING the metal trade, Messrs. Bruce & Cook, who are large importers and dealers, say: "We are able to see a marked improvement in trade. Since the passage of the tariff bill there is apparent a more general confidence, and an increase can be reported in the number of inquiries for prices, particularly with regard to tin-plates. Houses in the trade were inundated, after the passage of the new bill, with telegrams and letters asking why the shipment of tin-plates was delayed. The answer made in such cases was that, the nearer October 1 (the date at which the reduced duty was to take effect) was approached, fewer boxes would be found in stock, duty paid, as houses holding plates in bond could not be expected, in advance of the reduction in duty, to withdraw them except for actual requirements. A

good indication of gradual improvement in the metal trade is the satisfactory character of collections. Payments have never been more prompt than at the present. Dealers in the interior seem during the past year to have been putting their money into banks instead of into stocks. They are now in a good position, therefore, having light stocks, to create an active fall demand for all lines of metal products."

THE volume of railroad traffic is a good barometer of business conditions, and the showing which has been made by the roads of late is both interesting and encouraging In the following table a comparison is made between the total amount of the westbound freight (in tons) shipped from New York by all railways during the last twenty months and the amounts for periods of one year previous, together with columns showing increase or decrease:

MONTHS.	1893.	1892.	Increase.	Decrease.
January-June	783,057	772,317	1.4%	....
July	96,401	127,435	....	24.3%
August	103,756	144,297	....	28.1%
September	141,484	145,207	....	2.5%
October	106,469	127,235	....	16.3%
November	97,640	128,078	....	25.1%
December	85,591	130,766	....	34.5%
	1894.	1893.		
January	98,168	125,052	....	21.5%
February	91,713	116,007	....	20.9%
March	114,851	154,178	....	35.5%
April	106,385	147,571	....	27.9%
May	116,616	130,023	....	10.3%
June	120,635	110,387	9.3%	....
July	106,917	96,461	10.8%	....
August	125,000	103,756	20.5%	....

"There has been a marked improvement in business since the passage of the tariff bill," was the language of an official of the New York Central and Hudson River Railroad Company, "and its effect will shortly be felt by all the railroads. I refer first of all to the large amounts of merchandise which have been sold lately in New York city and are now going into the channels of distribution. It is too early yet to make predictions about the eastbound freight. Crop reports are uncertain where we come to matters of detail, but there is no doubt that the crops are very heavy, though not so heavy as to depress prices and demoralize business in the west. Already the railroads are beginning to make a good showing of traffic as compared with last year, and I believe that a still better showing will result from the crop movement."

THE collector of customs at the port of New York, the Hon.

James F. Kilbreth, in making a statement for THE ENGINEERING MAGAZINE, said: "The indications visible in the operations of this office are of an improvement in business conditions. It is not a marked improvement—nothing in the nature of a 'boom'—but it is enough to give reason for hopefulness. The first indication was in the shape of greatly increased withdrawals of imports after the passage of the new tariff bill. Many of the goods affected had been in bond for some time, awaiting the expected going into effect of lower duties. But the fact of their withdrawal under any conditions is an evidence of a consumptive demand for goods, and that renewed activity exists in commercial circles. Another indication of greater business activity is to be found in the increased volume of imports—free and dutiable combined—during the short time that has elapsed since the enactment of the new tariff law. It is too early yet to predict the effect of the law upon the extent of the revenues as compared with the receipts in previous years, though we are hoping to see an increase."

THE extent of building operations in New York, which indicate pretty fairly the conditions of business at different seasons, may best be studied by consulting the books of the municipal department of buildings, in which are recorded the estimated values of the proposed buildings, at the time that building permits are asked for. In a study of these figures by months for three years past it will be found that the period of greatest activity was during the spring of 1893. After the beginning of the financial panic in that year the figures for each month fell far below the corresponding month of the preceding year. The same condition prevailed during the earlier months of 1894, but, as will be seen from the annexed table, there has been an improvement of late. The estimated cost of buildings for which permits were granted in July, 1894, exceeded the figures for the same month in preceding years.

ESTIMATED COST OF BUILDINGS UNDER PERMITS GRANTED IN NEW YORK CITY.

	1891.	1892.	1893.
September	$3,631,558	$3,159,736	$1,195,195
October	4,488,160	3,801,283	1,527,905
November	3,644,391	3,271,912	2,184,904
December	5,422,928	3,610,017	1,582,089
	1892.	1893.	1894.
January	$3,053,465	$4,684,849	$3,268,848
February	5,378,709	5,042,303	2,956,958
March	8,817,725	7,144,080	4,253,614
April	11,204,540	9,810,072	6,167,558
May	7,004,070	14,705,068	8,613,002
June	8,049,740	7,018,767	5,456,909
July	4,630,947	3,820,710	5,282,203
August	4,700,148	3,085,343	3,768,577

In an editorial review of the business situation on September 17, the New York *Evening Post*, which ranks as a conservative and very high authority upon commercial affairs, had this to say:

Whatever claims may be made as to causes, of the fact of a revival of trade there is now no doubt. It has not come with a rush, with the exception of certain lines of business immediately affected by change of duties, but it is coming gently and gradually, as men like to see the rain begin after a time of drought. The barometers generally watched with most care are three: The clearing-house returns, the bank loans, and the blast furnaces. The first indicate in a general way the amount of the exchanges of goods that are taking place. The loans made by the banks indicate the existence of a demand by solvent borrowers which would not exist unless they saw how they could make a profitable use of borrowed money. The production of iron is significant because that metal is the basis of all industry.

If we glance at the recent figures showing the amount of bank clearings we find a rate of increase quite as rapid as is to be wished. The clearings during the month of August were in 1894, 3,564 millions of dollars, against 3,376 in August last year. For the week ending September 1 they were 767, while last year they were 700. For the next week the figures were respectively 809 and 731; and for the week ending September 15 they were 882 and 803. There has thus been a gain of about 10 per cent. during the last few weeks, with indications of a continued increase. No more rapid rate of increase than this, we incline to think, could be regarded as altogether healthy.

Turning to the returns of the New York city banks, we see that during the last week of August the loans increased very slightly over the amount of the previous week, but very greatly over the corresponding week of 1893. The figures for 1893 were $400,000,000, but for 1894 they were about $490,000,000. The following week showed again but a slight advance, although far in excess of last year, but the week ending September 15 showed an advance of over $3,000,000; an increase of over $100,000,000 beyond the amount last year, and very largely in excess of the loans of 1892.

We confess that we regard the extremely rapid increase in the production of pig-iron during the last few weeks with some anxiety. In the region west of the Alleghany mountains and north of the Ohio river, the production appears to be nearly as great as it has ever been. The weekly capacity of all the furnaces in blast on September 1 was reported to be 151,000 gross tons, and this is, we believe, within 25,000 tons of the maximum production recorded. We must go back until June, 1893, before this production is equalled. But what is startling is the contrast with the earlier months of this year, and especially of this summer. During no previous week has the capacity of the furnaces in blast exceeded 127,000, and on the 1st of June the number in blast was but 88, with a capacity of only 62,517 tons. The number has now risen to 171, and the capacity, as we have seen, to 151,113, as compared with 86,000 tons July 1, and 115,356 on the first of August. The stocks on hand, withal, are reported to have decreased. Since there appears to have been little change in prices, we must suppose that present rates are sufficient to induce increased production. If this be true, the whole industrial world will feel the advantage of the cheapness of iron, and this will of itself have an important influence upon general prosperity.

THE COST OF LIVING IN BRITAIN AND THE UNITED STATES.*

By Andrew Carnegie.

IF asked upon what subject the general opinion of Britons was farthest astray regarding the United States, one would not be far wrong in answering, As to the comparative cost of living in the old land and in the new.

It will probably prove a work of time and of some difficulty to remove an impression so generally entertained as that which finds expression in the words recently spoken by a high English authority—viz., that "the United States would be a perfect El Dorado for the workingman, if it were not for the high cost of living."

It is easy to show how this impression has arisen. The Briton arrives in New York and hires a carriage, which has been waiting for the steamer several hours: he is charged an exorbitant price; he orders a bottle of imported wine, and finds it much dearer than at home: he learns that the cost of clothing made to order from imported material is also much dearer: and these things strike him deeply, because they are the first impressions received. When asked upon his return upon what data he has reached the conclusion that the cost of living is dearer in the United States than at home, he invariably gives these three items, and stops there. But these do not constitute the chief sources of expenditure even to travelers, much less to residents. Asked how he found the cost of living at hotels, he remembers that it costs less in the Republic, where the charge in the best hotels is from fourteen to eighteen shillings per day, the latter being the extreme rate in New York. For this he has a comfortable room and all meals—breakfast, luncheon, dinner and supper. He also remembers that he could scarcely have such a dinner at the Metropole in London for the entire eighteen shillings, which pay for all meals and a room at the Windsor Hotel, New York. Asked how he found the cost of traveling, he figures a little and finds that it is just a little more than one-half, first-class, even including sleeping cars. The cheaper cost of railway travel per mile, and of hotels, is not nearly offset by the extra cost of cabs and foreign wines. The visitor buys no clothing, and if wise will follow the American example and use the hotel omnibuses or electric cars, and rarely, if, ever, use cabs, which are not

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an American institution. If the visitor wishes, however, to hire a carriage and pair by the day, week, or month, or for theater or reception, he is provided in New York at prices not beyond those charged in London—forty to fifty pounds per month, according to circumstances, and twelve shillings per night for a brougham; for an afternoon in the park the charge for a carriage and pair is even less in New York. It is undoubtedly a fact that the cost of travel, including all necessary expenditures per day, over equal distances, is much dearer in Britain than in America. But this fact affects only the few travelers, usually persons of means, and is of little moment. The great point is, as to the comparative cost of living to the mass of people, the wage-earning class of the two countries.

Let us calmly consider this. The income of the mass of workingmen, skilled and unskilled, is from £60 to £120 sterling per year. Now we must first learn the percentage of these earnings spent for each of the principal necessaries of life. According to the Bureau of Labor statistics of Massachusetts, the highest authority, these in England and America are as follows:

Income, $300 (£60) to $450 (£90) per year.			Income, $450 (£90) to $600 (£120) per year.		
Items.	American.	English.	Items.	American.	English.
Subsistence	64	81	Subsistence	63	78.75
Clothing	7	7	Clothing	10.50	10.50
Rent	20	13	Rent	15.50	10.37
Fuel	6	6	Fuel	6	6
Sundries	3	3	Sundries	5	5
Total	100	110	Total	100.00	110.62

This shows the increased cost of articles in Britain to be 10½ per cent. But prices in the United States have fallen since this table was made, much more than in Britain. In Charles Booth's valuable work, "Labor and Life of the People" (British), he gives the amount spent for food alone as from 60 to 50 per cent., according to the family revenues. In the broader term "subsistence," not only food, but all that enters the mouth is embraced. Thus "subsistence" is the chief item of cost for the workingman's family. It ranges from 64 per cent. in America to 81 in England. The reason for this difference is obvious. Of course, all food is cheaper in the United States than in Britain. The former exports it to the latter. Tobacco is very much cheaper. America grows tobacco, and only taxes it 3*d.* per pound, as against a 3*s.* 6*d.* tax in the Monarchy—fourteen times as great. Of course, what he drinks is cheaper. The duty on whisky is 20*d.* per gallon, as against 11*s.*—six times greater—in Britain, and it is made more cheaply in

Kentucky than in Ireland or Scotland. Upon beer the taxation is 4*s.* and 7*s.* respectively per barrel. Tea and coffee are free of duty to the American; they are taxed to the Briton. Sugar (raw) is free in both lands, but in the Republic there is a slight tax upon foreign refined. When the masses in Britain realize how heavily they are taxed compared with the workers of the United States, there will probably be a prompt demand for reductions upon articles embraced in the term "Subsistence," and especially for a free breakfast-table.

The low cost of what goes into the mouths of the people throughout the United States would surprise any British investigator who made it a study, but the cost of living in the forty-four States, occupying a continent, is to be determined not only in New York city, and in the cities and towns upon the Atlantic sea-coast, to which products of the great West have to be transported, but also by taking into account cost at the center of population, which is now near Indianapolis, Indiana, midway between Chicago and St. Louis, eight hundred miles inland from New York.

Having dealt, with say, three-fourths of the total expenditure of the workingman's family—namely, that for "subsistence"—and found that it cannot be otherwise than that the articles consumed must be cheaper in Indianapolis than in Manchester, by at least the cost of rail and ocean transport and merchant's profits, we come to the second item, which is "rent," consuming 20 per cent. of the earnings of the family in America and 13 in England. The British workman lives in a smaller house. The better class of American, as a rule, has three or four rooms; the Briton two. Rent is undoubtedly much higher in the newer land.

The next item in importance is "clothing," which represents 7 per cent. of the expenditure in the United States, and exactly the same percentage in Britain. This will, no doubt surprise most readers until the reason is given, which is, that while clothing made from the finest imported cloth is very much dearer in America than in Britain where the cloth is produced, clothing made from the American cloth is very cheap indeed and serviceable. It is, however, coarse and harsh, and not so agreeable to wear—harsher even than the Scotch cheviot. But the mass of the people wear it as they wear woolen underclothing of the same kind. Hence the masses are not affected by the duties placed upon the fine woolens, which are imported only for the rich few. I have before me advertisements in the American papers of complete suits of ready-made clothing ranging from two to three pounds—just the cost in Britain.

Here is a true story bearing upon this subject. A well-known member of Parliament, addressing his constituents in the Midlands

some time ago, told them that living for the workingman was much higher in America than in Britain, and said that the cost of clothing was three times as great. A copy of this speech was sent to his friend, one of the best-known men in the United States, whom the speaker was in the habit of visiting. A short time after, he visited his friend in the Republic, accompanied by his wife. One morning the host appeared at breakfast in a new suit which elicited general admiration, the English lady stating that it was "much smarter than the suit worn by her husband." The host then asked his visitor what he supposed the suit cost him; to which the unwary Briton replied, "Well, the suit I am now wearing cost me £7, and I suppose yours, in this terribly protected country, must have cost £12." This was his opinion after having examined the suit. "Well," said his host, "I paid just $4.50 (18s.) for this suit, and I wish you to take it back to England and show it to your constituents and tell them this." Amidst much laughter, this was declined. His host had seen in the village a traveling van from Boston, from which ready-made clothing was being sold, and asked the vender if he had a suit to fit him; to which he replied "Yes, and if you take a suit you can have it at wholesale price. Retail price is $6 (24s)." "Very good: send it to the house" It was promptly sent, with the result stated. Of course it was American material, not as smooth or as fine as the cloth worn by the honorable member; nevertheless, a good, smart suit. The price, however, was so very low that it is fair to record that I should hesitate to say that it was likely to prove serviceable. For £3, however, serviceable suits are easily obtained.

When we look at the amount of the extra fine woolen goods imported by the United States, we see how trifling it is, compared with the total consumption of wool. In 1890 the value of home woolen manufactures was $338,000,000—say sixty-eight millions sterling. The import of the high-priced fine foreign woolens was only $35,500,000—seven and a tenth millions sterling. It is safe to say that the value per yard of the foreign was double that of the domestic: hence the number of yards of foreign woolens used was not much beyond 5 per cent. of the amount consumed, and all by the few wealthy people, who alone use the high-priced foreign articles.

We have the same result with cotton manufactures, the value of the home American product being $268,000,000—fifty-four millions sterling; the amount imported being $28,000,000, not six millions sterling, which represents not quite 5 per cent. of the total consumption, assuming double value per yard for the foreign. The amount of cotton goods used by a workingman's family is considerable.

In regard to silks we have the following figures for the year 1890: product of American mills, $69,000,000—thirteen millions eight hundred thousand sterling; the imported manufactured silk, $31,000,000—six millions two hundred thousand sterling. It may safely be assumed that the value of silks imported, per yard, was double that of the domestic, so that more than four yards of American silk were consumed to one of foreign.

While upon the subject of clothing I may note two facts within my own experience. An American family, having numerous servants, resides part of each year in Britain. The servants pass to and fro, and thus have opportunities to purchase their clothing, boots and shoes, etc., either in the one land or in the other. The men-servants continue to purchase clothing in the old land. The women-servants find they can purchase to better advantage in New York. Boots and shoes are purchased by all in New York.

The second instance: A Scotch-American family with five children spend part of almost every year in Scotland. The able, thrifty mother formerly took the opportunity to supply her own and the children's clothing, etc., in Glasgow. Upon recent visits she has purchased nothing upon this side, and I heard her give as a reason, that she found that clothing for herself, and especially for her children, could now be purchased better and cheaper in New York than in Glasgow.

The well-known Free-Trade or tariff-reform writer, Mr. Schoenhof, was deputed by the State Department to report upon cost in the United States and Britain, and reported as follows some years ago:—

"So far as clothing and dry goods in general are concerned, I find that cotton goods are fully as cheap in the United States as here. Shirtings and sheetings, if anything, are superior in quality for the same money with us, so far as I can judge from the articles exposed for sale in the retail stores. Articles for underwear for women, made of muslin, are far superior in workmanship and finish, and cheaper in price, in the United States. Nor can I find that men's shirts, when chiefly of cotton, are any cheaper here. Of boots and shoes, if factory made, the same may be said. In workmanship and finish I find corresponding articles of the wholesale process of manufacture superior in the United States. This is true of clothing as well as of cuffs, collars, and like articles."

Prices of articles other than agricultural have fallen in the United States much more than in Britain since Mr. Schoenhof reported. This fall has been so great as to put the price of Bessemer, pig-iron, and steel billets at Pittsburgh lower than at Middlesborough; to enable American carpets to be sold in Britain; to tempt the leading American

shipbuilders to ask permission to tender for some of the new British war-ships; the Clyde Trustees to purchase their new and powerful dredgers in New York. It has also enabled the American manufacturer of agricultural implements to reach the British market, and the quarrymen to send granite from Maine to Aberdeen.

The next item which figures in the expenses of the workingman's family is "fuel." Speaking generally, this is much cheaper in the United States than in Britain. If we compare New York and London, New York receives anthracite coal as cheaply as London receives bituminous coal. The former will, at least, give double service, and it is said to yield three times as much. In the center of population in the United States the cost of coal does not exceed 8*s.* per ton. In the great western Pennsylvania and Ohio districts it is not more than 6*s.* The American has to use more coal in winter owing to the severer cold, and has more fires going in his larger house. Experts have found that the percentage of their earnings spent by the American and Briton on fuel is equal—viz., 6 per cent.

It has been common in Britain to attribute the supposed higher cost of living in the United States to the effect of the tariff. Now a little consideration will show that this impression is not well founded. The principal highly-taxed articles under the McKinley Bill are five: First, the extra fine silks of France; second, the fine woolens and linens of Britain; third, the extra fine linens of Germany and France; fourth, the high-priced wines of France; and fifth, Havana tobacco and cigars. The duties on all these are very high. Woolens 60 per cent. of their value, silks even higher, champagnes 32*s.* per dozen, etc., etc. This is our "Democratic" Budget. There is not a workingman in America who uses any of these articles. It is considered good policy thus to tax heavily the luxuries of the rich, and admit free the tea and coffee and raw sugar used by the masses. It is not probable that this policy will be reversed, or even greatly modified, however much talk there may be of tariff reform. Indeed, the wholesome tendency now seen in Britain to lay the burden of taxation upon the wealthy few who can best afford to bear it is not less strongly marked in the Republic. The necessaries of life used by the workers will probably remain duty free in the Republic and soon become free in the Monarchy, and the luxuries of the rich will continue to be taxed more and more in both lands.

The position of the supposed unfortunate farmer of the United States used to be cited, and the point made, that owing to the tax upon machinery he had to pay more for his agricultural implements than was otherwise necessary, but as the American has now the command of the world for agricultural machinery, and exports it, the farmer is no longer interested in the tax upon foreign machinery.

The appearance of the United States as an exporting country of manufactured articles, owing to reduced costs, is one of the notable events of recent years. Here are a few items: In the year 1893 agricultural implements were exported to many parts of the world to the extent of nearly £1,000,000; manufactures of copper to the extent of £900,000; cotton manufactures, £2,400,000; iron and steel, and manufactures of these, £6,000,000; carriages, cars, etc., more than £500,000; wood, and manufactures of wood, over £5,000,000 sterling, American furniture being now largely exported.

In the year 1892 the Republic exported as much iron and steel, and manufactures thereof, as she imported—viz., $28,000,000 worth in both cases—five and three-quarter millions sterling.

It is notable that musical instruments, valued at £360,000, were exported; glass and glass ware to the extent of £1,600,000; leather and manufactures of leather, over £2,000,000; paper and manufactures of paper, to the extent of over £300,000 (some English journals are now printed upon American paper); instruments for scientific purposes, £260,000; clocks and watches, over £200,000.

The export of manufactured articles rapidly increases year after year, but, unlike that of Britain, must ever remain totally insignificant as compared with the value of the total home production of manufactures, which was no less in 1890 than £1,750,000,000. The value of British manufactures in 1888 was not quite half as great, being £820,000,000.

The prosperity of a new continent like the United States is not to be gaged by its foreign but by its home commerce. As the new land more and more supplies its own wants, her foreign commerce must relatively decline; more of the cotton grown, for instance, being manufactured at home, and less going abroad, and so with all the natural products, as also with many articles now imported, which will be made at home.

In view of the facts here noted, and also the obvious fact, that subsistence must be cheaper in one country than in the other, and that this embraces three-fourths of the total cost of the necessaries of life for a workingman's family, how are we to account for the general impression still lingering in Britain, that the cost of living is higher in the United States? Simply for this reason: that while it is true that a pound sterling in the United States to-day will purchase more of the necessaries of life for the mass of the people than it will in Britain, and while the American workman has great advantages over his fellow British workman in consequence, still it does not follow by any means that the American workman lives as cheaply as the Briton—far from it. He has much higher wages. The report of the Senate Committee re-

cently made shows that the average percentage of American wages obtained by the British workman is only 56½ per cent.—not much more than one half—the principal handicrafts being made the basis of comparison.* Having higher revenues, the American is not content to live without what would be considered luxuries in any of the old countries of Europe. He earns more and he spends more. Therefore, in one sense it is true that the cost of living as the American workman lives is greater than that of the Briton as he lives. But it is none the less true that this arises from the fact that he lives in a different manner. For those similar things which are absolutely necessary the cost is much less in the newer land.

The American workman and his family can live very cheaply indeed if so inclined, or they can spend inordinately just as easily as in any other country. We find this proven by the expenditures of foreign workmen, especially Hungarians and Italians, who have in recent years emigrated to the United States in great numbers. The usual price paid by these foreigners to the keeper of the boarding-house is ten cents (5*d.*) per day for food. They usually sleep in wooden huts erected for them by their employers. In times of unexampled industrial depression, like the present, the ability of the masses of the people of the United States to live cheaply and yet comfortably is of the greatest moment, for it has shielded them from much acute suffering which would otherwise have resulted from the lack of work—an experience new to this generation of Americans, and likely soon to pass away, unless the faith of capital in the maintenance of the gold standard be again shaken. An equivocal note upon this subject, struck by the Secretary of the Treasury May last year, paralyzed the business of the country for the time—and recovery has been retarded by impending new legislation affecting duties upon imports.

Whether America be the El Dorado of the workingman or not, depends upon the workman himself. He and his family can now live for less than a family in Britain, if they will live as frugally. They are in the position of the old Scotchwoman I knew, who, being asked if she could live upon a certain sum as an annuity, replied, "Ou ay, I could live on half o't, but I could spend dooble." That is to say, a pound sterling in the new land, judiciously spent for the necessaries of life by the workingman and his family, will to-day purchase more of these in the new than in the old home of our race—a fact probably fraught with far-reaching consequences upon both sides of the Atlantic in the not distant future.

* But it is to be noted that since this report was made three years ago, wages have fallen in the United States, probably as much as 10 per cent., as compared with wages in Britain. This fall, however, is likely to prove temporary, as until the panic of July last year the tendency was to even higher wages than existed at the date of the report.

THE INDUSTRIAL DEVELOPMENT OF CHILE.

By Courtenay De Kalb.

THE republic of Chile is entering a new period of development, under the impulse of a sudden awakening of interest in technical industries. Conditions at home and abroad have combined to surround her with difficulties which will be lessened if not removed by providing remunerative employment for her people. Of a total population of 3,300,000 no less than 60 per cent. is classed as urban, and only a small proportion of this large urban population consists of artisans, and few of these are possessed of that knowledge of their trades which would rank them among "skilled workmen" as that term is understood in the United States and Europe.

When it is considered that this tendency to urban life is so pronounced that considerably more than a million people live in cities having populations of more than 30,000, and that there are thirty other cities with a population exceeding 10,000 each, we see at once that Chile is confronted by a very grave problem, indeed. Evidences of social discontent are abundant, although not manifested in ways familiar to those who live in countries where the mechanical arts have attained importance. There is nothing to strike for and nobody to strike against. In short, there is no employment to be had for the great multitude of idle hands. For months after the recent civil war outbreaks of mob violence and highway robbery were so common that many of the Chileans themselves felt that they were "sleeping upon a volcano." That they were not actually sleeping is shown by the fact, which merits admiration, that the newly-constituted authorities succeeded in choking every vent of the threatening social volcano which lay beneath them, and which lies beneath them to-day.

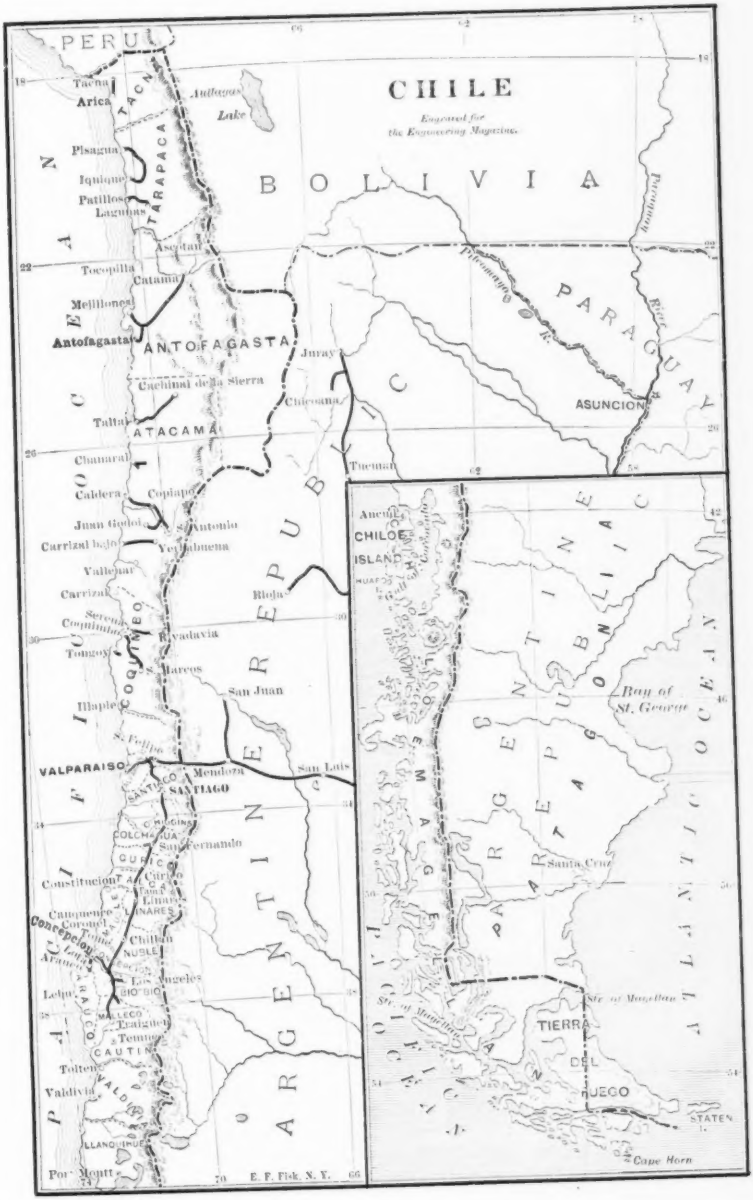
Still more admirable is the wisdom and foresight of that policy, favoring by every legitimate means an improvement of the industrial condition of the country, which is so conspicuous a characteristic of the government under the present administration. This is not saying that those in power have proved themselves wise in all their acts, that they have not made many blunders, nor that they have not at times flown in the face of their declared principles. But they have had many hardships to contend against. They assumed the responsibilities of government at a period of paralysis resulting from a disastrous war, with a national debt amounting to nearly $55,000,000, with exchange rapidly declining because of the depression in silver and from want of

confidence, and with diminishing importations lessening the revenues. In spite of all this the government has boldly committed itself to a policy of protection, and of subsidies to special enterprises: has appropriated money for a mining and metallurgical exhibition, and for other purposes the returns from which are entirely prospective.

There is no doubt that the principle of protective tariffs has taken a firm hold upon the minds of the Chileans. Protectionist clubs have been formed, the Society for the Promotion of Manufacturing has lent its powerful influence to the cause, the Union of Artisans, the Society for the Protection of Mechanic Arts of Valparaiso, and other similar organizations have taken the field, and the most important newspapers of the country have followed their lead. Fortunately there is already a fair nucleus around which to build up industries of importance. There are no less than 100 soap-factories in Chile; a native bottle-factory has been in operation at Lota for several years; and now the manufacture of illuminated glass has been undertaken. Woolen-mills are established near Santiago and at Tomé; a tobacco-factory in Valparaiso is running with a force of 120 employés; and there are other plants for the manufacture of cardboard, paper, bricks, earthenware pipes, enamelled-iron ware, cement, and chemicals. The only nail-factory in South America is in operation at Chillan. There is a small sugar-refinery at Viña del Mar, and sugar-mills are found on several estates. Almost all the blasting-powder used in Chile is produced in native factories employing the nitrate of soda of the country, and every important *hacienda* in the agricultural districts possesses a flour-mill as part of its equipment. Many of the latter are of the modern roller type. Ice-factories at Santiago and Valparaiso have proved successful, one in connection with the brewery and factory for carbonated beverages in Santiago having three machines of the Raydt and the R. Pictet systems, with a total capacity of two-and-a-half tons an hour.

In addition to these all the chief centers, such as Santiago, Valparaiso, Caldera, and Carrizal, possess large workshops, foundries, machine-shops, and saw-mills. In the workshops in Valparaiso locomotives, steam-pumps, Root blowers, and other machines have been made from iron and steel imported from the United States and Europe. In consequence of this the Society for the Protection of Mechanic Arts in that city has demanded that in future all locomotives and cars for the Chilean government railroads shall be of home construction.

A noteworthy manifestation of the growing sentiment in favor of a high protective tariff was made at the session of the Commission of Industrial Instruction in 1893, when representatives of all the principal trades insisted that not only was competition with imported goods im-


CHILE
Engraved for
the Engineering Magazine.
PERU
BOLIVIA
PARAGUAY
ARGENTINE REPUBLIC
PACIFIC OCEAN
ATLANTIC OCEAN
Tacna
Arica
Pisagua
Iquique
Patillos
Lagunas
TARAPACA
Ascotan
Antofagasta
ANTOFAGASTA
Juray
Tocopilla
Catama
Mejillones
Cachinal de la Sierra
Chicoana
Taltal
ATACAMA
Chanaral
Caldera
Copiapo
Juan Godoy
S. Antonio
Carrizal bajo
Ventanuena
Vallenar
Carrizal
Rioja
Serena
Coquimbo
Tongoy
Cadavia
Barcos
San Juan
Illapel
S. Felipe
VALPARAISO
Mendoza
San Luis
SANTIAGO
COLCHAGUA
San Fernando
CURICO
Curico
Talca
Constitucion
LINARES
Linares
Cauquenes
Coronel
Talca
Concepcion
Chillan
NUBLE
Los Angeles
BIO BIO
Lebu
MALLECO
Traiguen
Temuco
CAUTIN
Toltem
Valdivia
VALDIVIA
LLANQUIHUE
Port Montt
Asuncion
Tucuman
Ancud
CHILOE
ISLAND
Bay of
St. George
Santa Cruz
Str. of Magellan
TIERRA
DEL
FUEGO
STATEN
I.
Cape Horn
E. F. Fisk, N. Y.

THE CAPITOL AT SANTIAGO.

MUNICIPAL BUILDING IN SANTIAGO.

possible under the existing tariff, but that, under the prevailing conditions, there was lacking that stimulus which was necessary to call into existence a sufficient number of skilled workmen to meet the local demand for repairs and occasional jobs. For example, workers in tinplate are entirely unfamiliar with the use of modern machinery and tools. The same is true of the cabinet-makers, and in all branches of industry it is almost impossible to find master workmen competent to serve as foremen. The establishment of night-schools for manual-training was strongly advocated by all, but it was pointed out that, while these would be certain to enroll large numbers of students, both young and old, if there should be some certainty of promotion of industry by protection, the opportunity would just as certainly be neglected if no such inducement of permanent employment were held out.

As an example of the effect of one such training-school, limited to engraving, electrotyping, and photo-engraving, the director, Señor Lebe, reported that the average attendance numbered forty-eight, but the demand for men in this trade was so great that almost all the students left before completing their course to accept positions offered. The result of these deliberations was to approve a plan for such a school, absorbing that of engraving, and adding to it instruction, with the aid of suitable plants, in decorative painting, bookbinding, tinsmithing, and tailoring, to which wood-working and the manufacture of all kinds of leather goods are to be added as soon as the funds permit. There is already in existence an Agricultural Institute at Santiago, with schools of practical agriculture in other portions of Chile, and a School of Arts and Trades at Santiago has acquired a high standing, and is capable of turning out complicated machinery and appliances for railroad-work, steamships, and naval vessels. A valuable technical library constitutes part of the equipment of this school, and, owing to complaints presented by labor organizations, the government is proposing to have the more important foreign text-books translated into Spanish for the benefit of the workmen of the country. The National Society of Mines and the Society for the Promotion of Manufactures have both done excellent service through their monthly bulletins in disseminating the best current technical literature, and the latter society has been maintaining a night-school of machine-design and management of motive power.

There is a considerable demand for skilled labor in the gas, electric-light, and electric-railway plants which are becoming very numerous in Chile. There are gas and electric-light installations in no less than twenty-five cities. In the gas-works at Santiago are 288 retorts with a capacity of 1,525,000 cubic feet during twenty-four hours. Three gasometers are now in service with a total capacity of 533,960

THE EXCHANGE, SANTIAGO.

cubic feet, and a fourth is being built to contain 457,680 cubic feet. The consumption of gas in Santiago is still very low, however, not exceeding 1500 cubic feet per capita per annum.

Sixty per cent. of the coal used in gas-making in Chile comes from Australia, the remainder being from the native lignite-mines, excepting a small quantity of cannel coal from England employed to augment the illuminating power of the gas. Coal exists in Chile in the vicinity of Concepcion, in the province of Bio-Bio, and in Lota, Coronel, Arauco, Huena-Piden, and Lebu. Deposits have also been discovered in Valdivia, in the islands of Chiloe and Haufo, and in the straits of Magellan on the northeast portion of King William's Land. The mines of Bio-Bio are near the sea, and the coal is transported by steam- and sail-boats to the northern ports. The price of native coal varies from 10 to 15 pesos per ton, while English coal commands from 2 to 3 pesos more. The native coal is used for general metallurgical work, for gas-making, and quite largely for steamships. The production of Chilean lignites does not at present exceed 600,000 tons a year, but it is steadily increasing. The following analyses of two sam-

AGRICULTURAL COLLEGE, SANTIAGO.

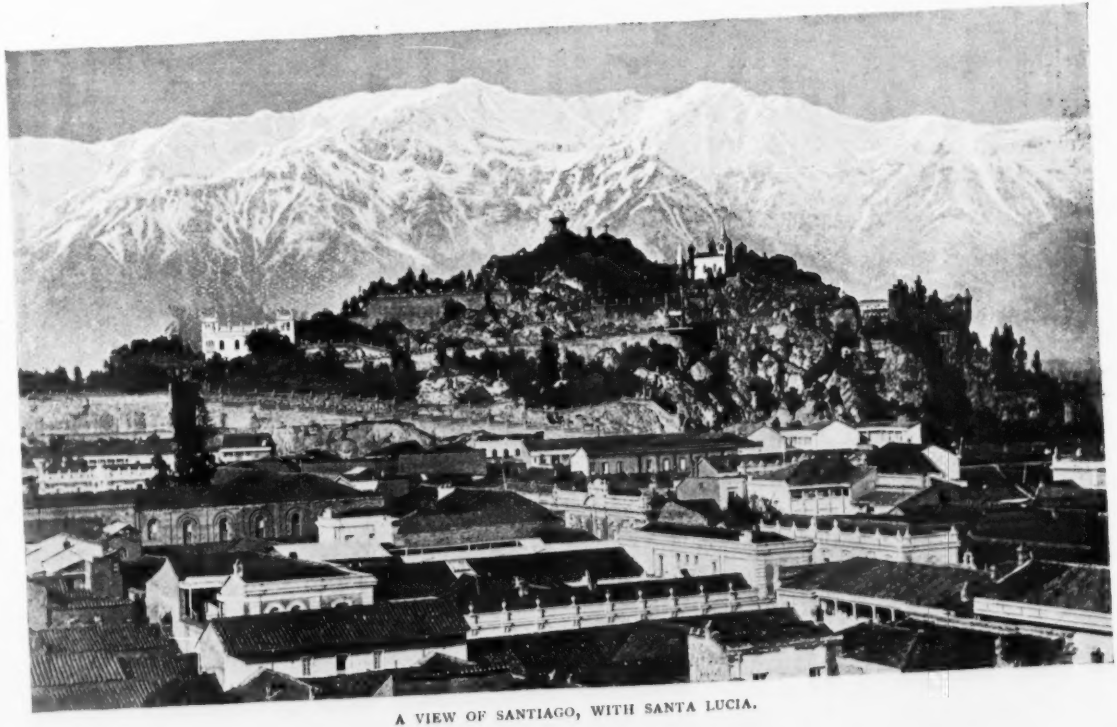
PALACE OF THE MINING EXHIBITION, SANTIAGO.

THE PASAGE BULNES (ARCADE)—SANTIAGO.

ples of brown lignite from Lota are fairly representative of the quality of that now in the market.

	I.	II.
Volatile Matter, percentage	40.8	40.2
Fixed Carbon	48.2	53.2
Water	4.8	5.0
Ash	6.2	1.6
Total	100.0	100.0

Sulphur is present in the proportion of from 0.02 to 0.1 per cent. It is noticeable that the sulphur content of these lignites is low in the



A VIEW OF SANTIAGO, WITH SANTA LUCIA.

more northerly mines, and increases toward the south. Exception must be made, however, of the deposits of Chiloe, whose composition closely resembles that of peat. The beds now being worked vary from 1 foot 11 inches to 5 feet in thickness. Some of the mines are worked to considerable distances below the level of the sea. The Chambique shaft, which penetrates the strongest vein now known in Chile, is 328 feet deep, while the Santa Amalia shaft is 1082 feet deep.

As might be supposed, the coke from these lignites is of inferior quality; moreover, it is compact instead of porous, and very brittle. Coke for metallurgical purposes is imported from the United States and Europe, and sells at 22 to 25 pesos (exchange at 24 pence) per ton. The coke produced in the Chilean gas-works is employed only for forge-work and domestic uses, and commands from 18 to 22 pesos a ton. The coal-tar from the gas-works is used in the cupellation furnaces in the silver-refinery near Santiago. One ton of the native lignite yields thirty-five gallons of tar.

Wood is still more extensively used than any other fuel. It is cut into short billets and sold by weight,—ranging in price from 13 to 14 pesos a ton, in the vicinity of Santiago, to 2 pesos and less in the south, where the forests are extensive. Charcoal, which is now used largely by private families, sells at 3 and 4 pesos for eighty pounds, but the government is proposing to establish large ovens in the wooded country in the vicinity of the gulf of Corcovado and Ancud, where it is said that charcoal can be produced at less than 10 pesos per ton.

Materials of construction for metallurgical works are not wanting, good clays for common bricks being abundant in all parts of the country, and many brick-yards being in operation. Such bricks sell now at from 15 to 20 pesos a thousand. Fire clays, however, are scarce. In the coal-districts, notably at Lota and Lebu, are good seams of semi-refractory clays, having the following average composition:

Silica, percentage	57.60
Alumina	28.00
Peroxid of iron	0.25
Lime	0.50
Magnesia	Traces.
Loss in calcination	13.50
	99.85

The bricks from Lota are the best, and have been found to stand well in the Siemens glass-furnaces which are in operation in that place. They sell at from 40 to 45 pesos a thousand, while imported fire-bricks sell in Valparaiso at 70 to 75 pesos a thousand. A large proportion of the copper bars exported from Chile is produced in rude reverberatory

GRAN HOTEL INGLES, SANTIAGO.

PRIVATE RESIDENCE ON THE ALAMEDA, SANTIAGO.

furnaces made entirely of common red brick, with a hearth of broken and pulverized quartz tightly rammed. Wood is used for fuel, and the whole operation is conducted by farmers and cattle-raisers who devote their time during the less busy seasons to this primitive metallurgy. The operations consist of a first heat, producing matte; subsequent heap-roasting; and a final smelting in the same reverberatory furnace, yielding the metallic copper, which is cast into bars of about 170 pounds in sand molds.

Chile is particularly rich in deposits of iron-ores, but no attempt has been made to utilize them for other purposes than fluxes. More than 4000 tons of iron-ore are produced annually from the San Cristóbal mine and shipped from the port of Coquimbo to Antofagasta to be used in the smelting of silver-ores. The San Cristóbal ores, however, contain considerable quantities of copper, but in the departments of Vallenar, Freirina, Serena, Ovalle, and Illapel, as well as in the central region (Tiltil, Lampa, Maipo), exist extensive deposits of hematite and magnetite, some of which assay as high as 66 per cent. of metallic iron. They are in most cases well below the limit in phosphorus and sulphur, and in many instances are associated with manganese. Large beds of the latter mineral are now being mined, the exportation in some years reaching 24,000 tons. One of the ambitions of the present administration is to create an iron industry on a large scale, and to this end it has sought suggestions from the National Society of Mines and

THE STRAITS OF MAGELLAN.

RESIDENCE OF SEÑORA COUSINO, SANTIAGO.

GROUNDS SURROUNDING RESIDENCE OF SEÑORA COUSINO.

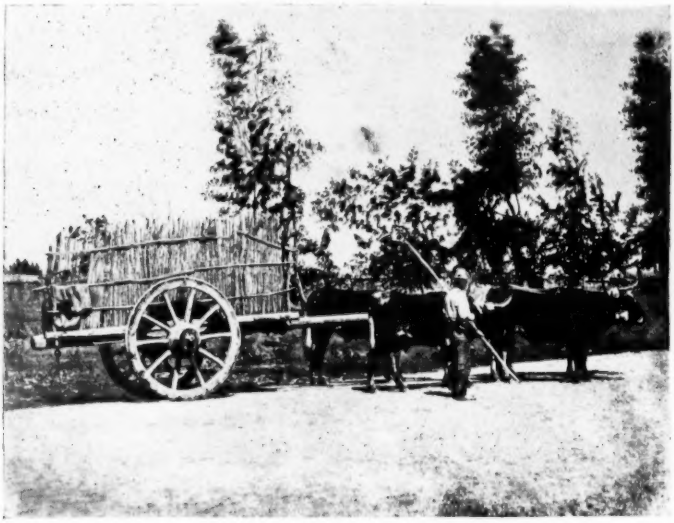
OLD BRIDGE AT SANTIAGO, OVER THE MAPOCHO RIVER.

from the Society for the Promotion of Manufactures. The latter society has responded with a proposal to subsidize iron-works having some definite annual production. It is probable that such a plan will be followed, and may be extended to various manufactures, those of cotton, linen, superphosphate, glass, earthenware, paper, and matches having already been mentioned in this connection.

The Mining and Metallurgical Exhibition, opened in Santiago in September of this year, is another venture of the government, intended both to stimulate mineral production on the part of the Chileans by economical methods, and to elicit ideas for the fostering of such enterprises. The Pavilion of Chile at the Paris exposition of 1889 has been erected in the grounds of the Agricultural Institute at Santiago for the electrical department of this exhibition, and three other buildings have been provided for metallurgical appliances, motive-power plants, hoisting and ore-dressing machinery, and chemical processes. In addition to these a German firm has erected a complete sulphuric-acid plant, with a capacity of 2000 pounds daily. Applications for space have been made by twenty-five firms in the United States, ten in England, and thirty-four in Germany.

It is not improbable that this exhibition will encourage many new

RAILROAD BRIDGE BETWEEN SANTIAGO AND VALPARAISO.



A PRIMITIVE CHILEAN OX-CART.

ventures in Chile. There is no little native capital, which has already accomplished important results, and it is natural to expect that the initiative in large expansions of the mining industry must be taken by the Chileans themselves. The difficulties of transportation and labor have been a great obstacle to investments by foreigners, and these difficulties are best overcome by those born in the country. The coal-mines are owned and operated by Chileans, and nearly all the lesser industries are controlled wholly or in part by them. They are also large owners of the stock of the Huanchaca of Bolivia Silver Mines Company, which in 1892 produced more than 6,000,000 ounces of silver.

The saltpeter—or nitrate of soda—industry is altogether the largest which Chile possesses, but it is almost exclusively in the hands of foreigners. The production in 1893 amounted to 1,037,927 tons, and the total output from 1878 to 1893 inclusive was 9,244,056 tons. The history of these workings is so well known as to render an account of them here superfluous. They yield a revenue to Chile of some 15,000,000 pesos a year, and she is now realizing considerable sums from the sale of properties to which she acquired title by paying the certificates issued by Peru to the original proprietors when that government undertook what was tantamount to a confiscation of them in 1875. The government is at present highly dissatisfied with the state of

the nitrate industry, which, it is charged, is conducted in an uneconomical manner, with antiquated machinery and clumsy methods. On the other hand, the nitrate companies fear that the installation of improved plants, tending to reduce the cost of the product, will only encourage Chile to increase the duties, since those from nitrate of soda constitute fully two-thirds of the total revenue of the state. This presumption may and may not be just, but it is only fair to point out that the Chileans argue that, since the production of sulphate of ammonia, which is the most dangerous competitor of nitrate of soda, has augmented to 23 per cent. of the total output of the mineral nitrates, it is necessary to offset this influence by lowering the cost of the latter article, thus encouraging a larger consumption, which would, without changing the rate of duties, effect that increase of revenue which she desires.

As a by-product from the manufacture of nitrate of soda, there result annually some 800,000 pounds of iodine, forming the larger part of that consumed in Europe. Large deposits of borax also exist in these northern provinces which Chile acquired from Peru and Bolivia, which are being worked to some extent.

THRESHING WHEAT IN CHILE.

The Chileans are fully aware of the need of improvement in means of transportation if any growth of industry is to be accomplished. The state now owns and operates 686 miles of railroad, and private lines bring up the total to 1847 miles. There are under construction an additional 448 miles, and a new railroad law has been passed rendering it as easy for future railroad companies to obtain charters, with full powers to acquire right of way, as for ordinary commercial companies to effect their organization. This plan is expected to stimulate the building of small lines to serve the interests of agricultural communities and smaller manufacturing and mining enterprises. Attention is also bestowed upon the common roads. The official records show 41,920 miles of public highways, and 24,800 miles of municipal roads, now open in the republic. These are mostly in an execrable condition, but in 1892 $550,000 were expended upon their improvement, and $450,000 were appropriated for this purpose in 1893. The seventy-eight navigable water-courses, aggregating 2852 miles in length, are being improved and added to. Fourteen bridges of various kinds were built by the state in 1892, and five more are being constructed or are under contract to be built.

From this very imperfect review it will appear that Chile has already made substantial progress, earning a fair right to the title of the "Yankees of South America" which her people often claim for themselves. But the growth of her urban population has been utterly disproportionate to the development of her resources, and the present striking activity in all quarters tending to a development of technical industries is a hopeful and healthful sign, showing that the people realize their weakness and their danger, and at the same time perceive clearly what remedy to apply. If they cannot find work as producers of raw materials, they must find work as artisans.

DEVELOPMENT OF THE STEAM-ENGINE GOVERNOR.

By Henry J. Conant.

> And thus I'll curb her mad and headstrong humour :—
> He that knows better how to tame a shrew,
> Now let him speak ; 'tis charity to show.
>
> —*The Taming of the Shrew.*

THE Gentleman of Verona who married a shrew for her dowry, and proceeded to tame her, certainly undertook an easier task than was accepted by the inventor of the steam-engine, when the operation of his first crude hand-engine had demonstrated the feasibility of the use of steam as a motive power, and pointed out at the same time the necessity of providing some means to bring it under self-control.

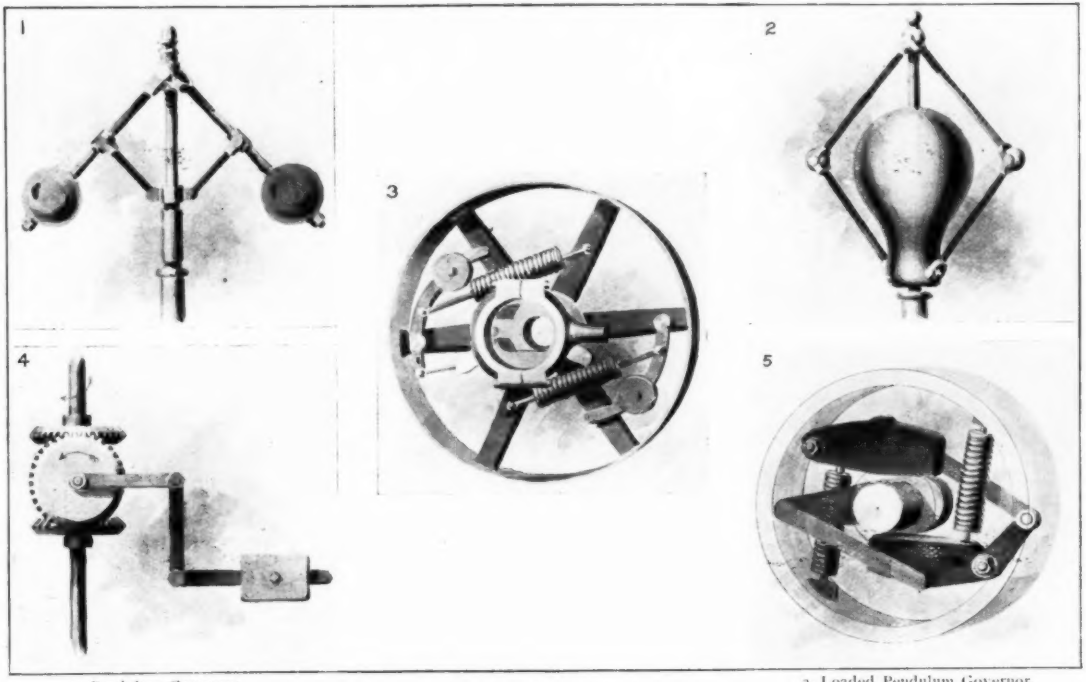
It may fairly be said that the invention of the steam-engine, in any modern acceptance of the term, was not accomplished until some method had been conceived for making it self-regulating. To do this Watt applied his well-known governor. The device he used was the pendulum form of governor, which even to-day may occasionally be found, on some antiquated slide-valve engine in the backwoods, in substantially its primitive form. It was made to act directly on the throttle-valve and performed its office by controlling the steam pressure at the cylinder as changes in load might require.

If Watt's governing devices are considered in their entirety they possess little but historic interest, for the type of engine which grew out of his early designs is now so little used that it may be considered obsolete.

The subsequent introduction of the cut-off, and the use of steam expansively in the cylinder, offered new opportunities in the way of regulation and marked an era in the history of the steam-engine governor, as well as in the broader field of steam engineering.

Important changes were involved in the duties of the governor, and its action became in most cases indirect. The intermediate mechanism employed for operating the steam valves was so designed that the governor might, through its agency, vary the point of cut-off, and thereby maintain control over the speed of the engine by proportioning the mean effective pressure on the piston to the work to be done.

In a sense, therefore, it might seem necessary for clearness in discussion to treat the valve gear as a part of the governing apparatus. Such a course, however, would lead at once to a consideration of a multitude of devices for manipulating the steam valves, ranging from



1. Pendulum Governor.
4. Siemens' Inertia Governor.

3. Sketch of Shaft Governor.

2. Loaded Pendulum Governor.
5. Modern Inertia Governor.

the comparatively simple mechanisms of the single valve automatic engines, to the various complex valve motions adopted by builders of engines of the Corliss type. All such would no doubt be found interesting, and many exceedingly ingenious, but as they are really only the tools with which the governor proper may do its work, and as any attempt to consider them would not only lead to almost endless digression, but add nothing to an understanding of the operation of the real governor, no further reference to them need be made.

With this view of the case it is easy to glance over the present types of governors and find that, with a few important exceptions, they remain in principle but little changed from the first crude device which Watt employed, and that they retain in a measure its defects.

THE pendulum governor as commonly used is a centrifugal governor pure and simple. Gravity is the restraining force opposed to the centrifugal action of the governor balls. Such a governor in its elements would consist of a pair of heavy balls suspended by arms from a central rotating spindle which derives its motion directly from the movement of the engine. In the simplest form of such a governor the different positions assumed by the governor balls by reason of their changing centrifugal forces at different speeds, would be made to operate directly on the valves to effect regulation.

The steam-engine governor was first used in this elementary form. But while it no doubt answered very well the requirements of those early days, a very little experience demonstrated its limitations and defects, and led to a study of the laws upon which the action of this class of governors depend.

AN analysis would show the position of the balls of an elementary centrifugal governor to be independent of their weight or their distance from the point of suspension, and determined only by their angular velocity. It was readily seen however, that any means by which the effect of gravity on the balls could be increased without augmenting their centrifugal effects, would produce a greater change in position for a given change in speed, and the governor be made more sensitive thereby.

The loaded pendulum-governor, as it has been called, was the natural outcome of such knowledge, and brought about at once a decided improvement in action. Loading of the governor has been accomplished in some instances by simply attaching to the balls a weight, the center of gravity of which lay in the axis of the governor spindle, in such a way, that it might act with gravity to cause them to fall, but without otherwise affecting them.

In other cases the action of gravity on the governor-balls has been reinforced by springs, and this method of loading the governor, while not perhaps a mechanical equivalent of the first, is yet capable of producing substantially the same results.

In the course of its development the pendulum governor has experienced many other modifications of design of a more or less interesting nature. Attention would be attracted to the parabolic pendulum governor, a refinement undoubtedly due, from its nature, to some one of a mathematical turn of mind. In this form of governor the balls are guided by a properly curved pair of surfaces, or suspended by flexible arms from evolute cheeks, in such a way that their path would take the form of a parabola. Since the subnormal of a parabola is always constant, the height of the governor would not change, and such a governor would therefore remain steady at one speed only, and be of course very sensitive.

Constructive and other difficulties have no doubt operated to prevent a general adoption of this form but it has sometimes been approximated by suspending the balls in the usual manner from points without the axis of rotation, corresponding to mean positions on the evolutes of the parabolas.

Other modifications of the centrifugal governor of a more radical nature have been made necessary by modifications in engine design, and a class of governors developed, which at first appears to constitute a distinctly new type. Reference is had to the shaft, or fly-wheel governors, now so widely used.

Such governors, however, with a few important exceptions* are really centrifugal governors in which the centrifugal forces acting are entirely counterbalanced by springs, thereby permitting their axes to be made horizontal. There exists nevertheless a distinct difference, for when this is done, new features are necessarily introduced by reason of the altered plane of action of the weights. The effects of these have rarely been treated in any useful way, and designers of fly-wheel governors as a rule have been content to develop their centrifugal effects alone.

Sufficient power is usually given to these governors to enable them to act directly on the valve motion, through one or more eccentrics whose relative positions they control.

It must already be evident that in order to perform its work at all,

* Among the exceptions noted may be mentioned various forms of dynamometer governors, which have been used, and at least one shaft governor in which no springs are used; gravity being retained as the restraining force, by the aid of a hollow shaft and various bell cranks and levers. But the most important exception is an inertia shaft-governor which has recently been perfected, in which centrifugal forces are subordinate in the act of governing, and inertia becomes the controlling feature of the governor. H. J. C.

the weights of a centrifugal governor must alter their positions, and it will also be clear that when the governor acts directly on the valve motion, a measurable amount of force will be required to overcome frictional resistances. In some cases these are quite appreciable. Since the only force available to perform this work must be derived from a change in moments due to a change in velocity, it is apparent the governor would be restrained from operating at all within certain definable limits of speed variation.

It follows from this that there is in all governors of this class a deplorable feebleness of action, since for small changes in speed the corresponding changes in momenta are slight. Thorough lubrication becomes therefore an important consideration, and if long continued runs are to be made, means must be provided for effecting this continuously.

It is true that by relieving the governor of the greater part of its external work through the intervention of so-called tripping gears, or equivalent devices, the evil effects arising from these sources may be largely reduced. Yet the element of weakness still remains. The use of the tripping gear, moreover, is confined by reason of mechanical limitations to slow running engines, and this defect becomes therefore in general practice a matter of considerable importance.

But by far the most serious defect in all these governors lies in the fact that time is required to alter the positions of the weights. The governor cannot act until after the speed has changed.

How serious a defect this is, may be seen by considering for a moment the operation of such a tardy governor under frequent and wide variations in load, now so common.

It is evident that a lengthening of the cut-off due to a previous increase in load may occur at a time when by reason of its lateness, the load has fallen off, and a shortening of the cut-off is required to properly control the speed. This condition of things is by no means hypothetical, but in many conditions of service, is just what occurs.

A GREAT amount of effort has been expended in the endeavor to confine the results of these inherent defects within allowable limits. Designers have so far succeeded, in a variety of ways, that it has been possible, with any of the better class of engines to-day, to obtain excellent average results.

Modern requirements, however, have become so exacting that good regulation can no longer be comprehended in averages. Good regulation implies small variations of speed reckoned in revolutions per minute. But it means more. It means that there shall be no appreciable variation from stroke to stroke.

Whatever may have been the influences that controlled it, we recognize the fact that for decade after decade, the development of the steam-engine governor has proceeded on lines essentially weak. At most the type of governor in almost universal use to-day does not approach in theory, and scarcely approximates in practice, the requirements of perfect governing. It is clear that a perfect governor must act simultaneously with every incipient tendency to change in speed, and with sufficient vigor to eliminate the effect of all frictional resistances. Its duty is to establish—not an average, but a rate.

In view of all that has been said such a degree of perfection might seem beyond attainment. There has grown, however, out of an application of the familiar force of inertia a new line of development, which has led at once to a new order of results, the remarkable effects of which are only recently receiving proper appreciation. This does not appear to have been brought about, as has often been the case in other instances, until the possibilities of existing forms had been exhausted, and further improvement made radical departure necessary.

And although the more recent achievements in the inertia governor are so entirely original in their nature, as to give no suggestion of anticipation, it is nevertheless true, that a form of governor not generally known, embodying an application of the inertia principle in a crude way, was at one time tried, and subsequently discarded as impracticable. It has long lain forgotten, and only claims casual notice now, in the light of what is being done in lines at least remotely related.

This early attempt at improvement, although of little merit in itself, must now possess some little historical interest, and may be made to serve as a profitable introduction to a description of the modern inertia governor. Its conception was due to Siemens, by whom it was offered as a solution of the difficulties experienced with the rough form of pendulum governor in general use at the time. He retained the conical pendulum—but made it very heavy, and instead of driving it directly from the engine shaft as was usual, he introduced an epicyclic train of three equal gears, so arranged, that the intermediate gear was permitted a limited lateral movement, sufficient to open and close the throttle valve, to which it was connected by means of suitable bell-cranks and levers. The power required to maintain the pendulum in rotation came primarily of course from the engine. The lateral pull on the intermediate gear due to the constant resistance offered by the pendulum at its normal speed, was just balanced by a weight attached to one of the bell cranks.

So long as the speed of the engine remained constant, the speeds of the first and last gears in the train would be the same, and the intermediate gear with its throttle, would remain delicately poised in whatever position had been last assumed.

Suppose for a moment that with such a governor the speed of the engine were to change. Only two things could happen. Either all gears and pendulum would have to change their speed coincidently with that of the engine ;—or the intermediate gear would be carried to one side or the other to compensate the change in speed.

The pendulum, being massive, would refuse, by virtue of its inertia, to alter its velocity except by the expenditure of considerable energy. The intermediate gear. on the other hand, being counterpoised and free to move in either direction, would do so, and act immediately upon the throttle in a most positive manner. In fact the power employed to operate the valve would be derived from the engine itself, and act simultaneously with its change of speed.

So extremely sensitive can this device be made that a very small fraction of a revolution would suffice to move the regulator over its entire range. *

The device was crude therefore only in its application. In those days of universal slow speeds and rude engines, the perceptible retardation in passing the dead centers, and irregularities in speed due to other causes, would introduce sufficient disturbance to necessitate many complications in the form of dash pots, dippers, or other like expedients ; and it is quite probable that the one great virtue of this governor of Siemens was the cause of its final abandonment.

It seems strange that the inertia principle, so rich in possibilities, should have remained so long unused. Yet it appears to have lain forgotten until its comparatively recent employment in an entirely different manner, and in a way beautifully consistent with the natural development of the fly-wheel governor.

In general arrangement the inertia shaft governor is not unlike the ordinary fly-wheel governor. The governor weights are made unusually heavy—and their mass so distributed that their centers of gravity fall as far as possible from the path of their centers of suspension.

Their moments of inertia referred to the centers of suspension are therefore great in proportion to the moments of their centrifugal forces referred to the same points of support.

If such a governor be revolving uniformly on its axis, its parts will

* A similar device for another purpose was successfully employed at one time in the Astronomical Observatory at Greenwich in connection with a clock train and other mechanism to provide an absolutely uniform movement of a drum, on which, by the aid of an electric current, it was possible to record the exact time of transit of the stars. H. J. C.

remain undisturbed in whatever position they may have assumed under the balance between the centrifugal forces of its weights and the restraining actions of its springs.

Imagine for a moment that the weights instead of being massive, were light, or that their centers of gravity lay on or near their circumference of suspension. Their effective inertia then being insignificant, they would readily accompany the engine in its changes of speed and no new position would be taken, until the speed had changed enough to develop a sufficient difference in centrifugal force to operate on the valve motion—as in the case of the pendulum governors.

Now suppose the weights to be heavy, and distributed as first described. They will, by their very considerable inertia, refuse to follow a change in engine speed, but simultaneously with any such tendency, and before centrifugal action could come into play, will assume new relative positions. The adjustment of the eccentric necessary to thwart these tendencies is therefore accomplished as in the case of Siemens' device, coincidently with any incipient change of speed, by a force coming from the engine itself, the power of which by suitable designs may be limited only by the strength of the governor parts.

The heavier the weights, the more obstinate their resistance and hence the quicker their action. Their relative motions may be still further augmented by placing the point of attachment to the eccentric, as far as possible from the point of suspension, thereby multiplying the speed of action.

As, in the case of Siemens' governor also, the operation of such a governor may be made so instantaneous and positive that the entire range of adjustment may be covered in a small fraction of a revolution, under the influence of a slight disturbance in speed.

It is evidently to the modern high speed engine, offering as it does many opportunities for regulation each second, that such refinements are applicable, if advantage is to be taken of them to the last degree.

If the inertia governor be carefully analyzed it will be seen to consist in reality of two distinct elements;—a primary centrifugal governor, and an inertia governor, both combined in such a manner that no additional parts are required, and so that both operate as one. Inertia is made to step in just where centrifugal action fails, and at once eliminates from the governor the serious defects that had previously existed.

It might properly be considered a compound governor, in which the function of the centrifugal component is to set a pace, and the office

of the inertia part to maintain its rate. The details of design of such a governor are far from being as simple as the principles on which it depends.

Fortunately, however, all that has been accomplished in the slow development of the centrifugal governor and the insight that has been obtained into the complex forces that determine its action, are by no means lost, for a thorough knowledge of its laws and refinements is essential to any successful application of the inertia principle.

The modifying influences of a great complexity of disturbing elements involving the varying centrifugal forces of all parts of the governor, in their many different positions;—the varying leverages;—the constantly changing inertia of the eccentric and valve motion which it actuates; and many other forces must be taken into account.

Some of these may be compensated, some made useful, proper allowance made for others; and the effect of all combined in a way to produce the desired results. Ingenuity has been brought to bear where mathematics has shown defective design, and the art has finally been brought to a high state of perfection; only, however, through the aid of this passive-acting, ever present force of inertia.

THE MANAGEMENT OF MEN IN MILLS AND FACTORIES.

By W. H. Wakeman.

THAT there is a way to succeed in the management of men in mills and factories, and many other ways that fail to secure the desired result, no reader of the history of labor troubles will attempt to deny, but just what plan to this end will prove the best one is still an open question. Neither can it be expected that any one plan will fit all cases, for that which proves effective in one instance may be useless in others. Strange as it may seem, there are still those who believe that physical strength is an important factor in this vexing problem, and that the foreman or manager who has the power and brute courage to promptly knock down an employé who is rebellious, or inclined to work to the disadvantage of his employer, is the proper one to be placed in authority. That such men sometimes do succeed in conducting a business profitably is no proof that their methods are good on general principles, or that they are the best that could be devised even in the special cases in which they succeed. There is one thing in their favor, however. When a delinquent is punished in this way, his punishment is not shared by those who are dependent upon him for their support, who are entirely innocent of any participation in his misdoings.

There is much to be said in condemnation of such a practice as is mentioned above, and many reasons for the belief that it is not good policy in any case. We can see nothing in it to warrant the idea that such a course will cause the laborer or the mechanic to have his employer's interest at heart, and, without this most desirable qualification, he will not perform his duties properly except as he is closely watched, and this state of affairs is to be avoided for obvious reasons. A certain foreman once said to a dilatory operative: "John, it takes half of my time to watch you." "Sure now, it takes all of my time to watch you," was John's unexpected reply. In the meantime what is to become of that keen appreciation of the value of time, without which it is difficult to make any business successful?

The almost universal penalty for the infraction of factory rules and regulations is immediate discharge, but it is quite evident that the enforcement of this rule can never make any radical change in shiftless and vicious employés, for how can a man become a valuable hand after he is debarred from taking his accustomed place in the mill or factory?

It is well understood that such punishment is not and cannot be of any benefit to the culprit, but is administered for the purpose of being an object-lesson to those who are still in the employ of the mill-owner, but it is also well-known that it does not always have the desired effect. We do not say that a man should never be discharged for a misdemeanor, but if his punishment is to have a good effect upon those who are retained, they must be convinced that it was merited and that no injustice has been done. It is quite often the case that, when an employé is discharged, his comrades are filled with resentment towards the foreman or superintendent who ordered his dismissal. Then the punishment does not have the desired effect on those who remain, but just the contrary. The fact that one man has the might to say that certain operatives shall no longer have a chance to earn their living in a certain place does not make it right for him to issue an order to that effect, for while some people formerly believed that "the king can do no wrong," the number who still hold to that doctrine is very small and continually growing less. The system of imposing fines upon those who spoil material, or produce imperfect work, has an element of justice in it, but, nevertheless, if a portion of a man's earnings is withheld, his family must suffer for it, although they were in no wise to blame for the fault. Can it be claimed that such a system is wholly just?

The practice of suspending an employé for a certain definite period comes under the same head. The prospect of being out of employment for a month has caused many a man to become discouraged, and the punishment has had the effect of making him worse instead of better, as the intention was, for there is always a large class of men to be found in every community who cannot or will not make good use of such time as may be at their disposal, but will spend it in drinking or carousing. When a man returns to his work after such a period of enforced idleness, it cannot be supposed that he will entertain particularly kind feelings for his employers, or be filled with a desire to work for their interests in every way possible. It is to be expected that he will be more ingenious in avoiding detection than he was in the past, but there is no reason to believe that his spirit has been changed, or that his nature has been improved by the fact that he has been deprived of work for a month.

If all of these methods fail, then, to what shall we turn for success? The guilty must not be allowed to go free, else all discipline will be at an end, and anarchy and confusion prevail. Having stated our belief that the foregoing punishments are seldom reformatory in their character or effects, it is in order to explain a method that may produce desirable results.

Every man who is worthy of the name has a desire to be consid-

ered honorable, honest, and square in all his dealings, and wishes to be treated by his superiors as if he were such. Now, when a man is careless and thereby causes a loss to the people who furnish him with employment, if he is called into the superintendent's office and his mistake is pointed out, and its effects portrayed to him in lively colors by means of kind but forcible language, and if, when this matter is made clear to him, he is told to go back to his work and be careful to see that the offense is not repeated, it puts him on his honor to do better in the future. If he proves by his conduct that he is striving to be worthy to retain his position, then it is evident that he is more valuable than ever before. If his mistake or blunder is repeated within a short time, then let his name be put on a bulletin-board provided for this purpose, so that all his colaborers may see it and know of his disgrace. This should be accompanied by a reproof more stern than before, but at the same time it should not be abusive in its character, and on no account should the superintendent allow himself to indulge in any form of profanity in an effort to make his remarks more forcible. If a man demonstrates that he is incorrigible, it will be necessary to discharge him, but even then it is a great mistake to use harsh language at such a time, or to send a man away without giving him notice of the intention to dismiss him. If he has proved to be unsuited for the work done in one factory, it is no evidence that he will not give satisfaction in another. If he finds the discipline in one place too severe, and the rules and regulations too exacting for him in the employment of one firm or corporation, it does not of necessity follow that he will not be able to meet every requirement in another place. It is not impossible to keep the good-will of men, even though they can not be retained in your employ, and no man ever attained such a height in business or social circles as to be able to afford to lose the good-will of his fellows. He may ignore some of them, but at the same time he cannot tell how soon these same men may be in positions where their influence will tell heavily either for or against him.

The plan here described of a system of punishment without loss of time or situation is not an untried one, but it has been tested on a rather large scale and proved to be a success. We do not claim that the same reproof or treatment in general will apply to all men alike, for we know to the contrary, but no punishment that deprives a man of self-respect, or the respect of his comrades, can be termed an unqualified success. Such a system as we advocate must be carried into effect by men who thoroughly understand human nature, and are wholly in sympathy with the proposed plan. If they do not possess these qualifications, then it will certainly prove a failure.

The writer once went to the superintendent of a factory to intercede for a friend who was not receiving fair treatment, but, even before the case was fully stated, he was confronted with the information that if he was dissatisfied, another man would be secured for the place at once. To adopt such a course as this is a great mistake on the part of manufacturers, for its effect is to arouse hostility and revengeful feelings, and no good can ever come of it. It would require but a short time to listen to a complaint of this kind, and, if it is a just one, to admit it and make some change for the better, or, if there is no ground for the complaint, to say so and give reasons for the decision. A conciliatory course in such matters has saved the annoyance and expense of many a strike and boycott, and both parties have maintained their dignity and self-respect at the same time. Employés are continually complaining that they are not respected by their employers as they should be. A careful analysis of a large number of such cases has convinced us that in a majority of them employés receive all of the respect that they deserve, but men are not apt to admit this, for, no matter how ungentlemanly may be their conduct, they appear to think that they are entitled to all of that deference which is almost universally shown to the dignified employé in whatever station he may be found. It has been a source of amusement to the writer at times to note that while the head of a firm will frequently recognize his employés on the street, some of the officers who are lower down in the scale appear to consider it beneath their dignity to admit that they know them. These may be considered small matters by some, but nevertheless they all have their effect in shaping the good or ill feeling existing between employer and employé.

It is very discouraging to men who are placed in charge of a department in a shop to experience difficulty in getting supplies necessary to carry on work to an advantage, and also in having repairs made at proper times. The foreman-blacksmith reports that he wants certain kinds of steel and iron at a stated time, but when the time arrives and he makes inquiries as to the delay, he discovers that the goods have never been ordered. The foreman-machinist orders tools that he needs for immediate use, but they do not arrive on time, and, when they do come at last, their number or quantity is less than he ordered. The box-maker orders lumber, but he cannot get it when wanted. The brush-maker orders wire and bristles, and has to wait a day or two before he sees them, and so on through the whole list. While we are well aware that there are sometimes good reasons for these delays or changes, in other cases there are not, but it seems as if, like the ancient Egyptian taskmasters, the shop-owner of to-day wants the bricks made but does not want to furnish the straw. We

have known cases where coal was not furnished to the engineer until the last of that on hand was in the fire, and the engine was shut down waiting for more. If a man sends in orders for more material than is needed, they should be cut down, but nothing tends more to sour the disposition of the foreman of any department than to have his directions or requests in such matters totally disregarded. Again, nothing will make an engineer feel discouraged quicker than to report time after time that certain repairs or changes are necessary for the efficiency of his plant, and then to see the owner bring in some outsider who knows little or nothing about the place and its needs, who readily says that no alterations are necessary, and to find that this man has more influence with his employer than he (the engineer) can exert; yet scores of steam-plants are run in this way, and, in a great many of them, the engineer is right.

Such management of men is not confined to small plants, but is frequently to be found in places where many tons of coal are burned every twenty-four hours, and where a small percentage saved would amount to several thousands of dollars in the course of a year. The proprietors of these factories wonder why it is that, when they secure a good engineer, they cannot retain him, while their neighbors keep their engineers for years without a change. No self-respecting engineer will stay in a place where he is only expected to do manual labor or to superintend it, and the advice of a superintendent or bookkeeper is considered of more value than his own. Why do not manufacturers and steam-users understand this and act accordingly? The reply to this is sometimes to the effect that their engineers are not competent to tell what is needed, and superintend the alterations and the additions deemed necessary. To this we should simply say: "Then get one who is competent, without further delay." But there are cases where, if the engineer received the least encouragement, he would be much more interested in his work and be valuable in more than direct proportion. An instance occurs to us in which the advice of a superintendent was taken in preference to that of the engineer, and a large sum of money spent in making alterations on the engine, the result being that it costs about $5 per day more to run it now than it did before the changes were made. An engineer may be obliged to stay in such a place for awhile, but under such management it must not be expected that he will be contented, and under such conditions plants are seldom operated to the best possible advantage.

It sometimes becomes necessary to reduce the wages of employés to meet changed conditions of business. Now it is not to be expected that this will give satisfaction in any case, but we do maintain that it makes a great difference how the announcement of such reductions are

made. To issue a peremptory order to that effect, implying or asserting that those affected by the new terms can accept them or pack up their tools and leave as soon as they choose, is one way. To take a little more time and explain that the market price of manufactured goods makes retrenchment necessary, is another. The average American workmen is capable of adapting himself to changed conditions, and will do it cheerfully, provided he is convinced that such changes are necessary, but where it is plain that a reduction in his income is made for the sole purpose of increasing the income of his employer he naturally objects to such management and will do everything in his power to make such an innovation unprofitable and unsatisfactory.

Again, men are sometimes compelled to work for low wages, and operate machines that are antiquated, in poor condition, and unprofitable in results, when the introduction of new machinery would enable them to earn more money for themselves and for their employers. This state of affairs exists where there is ample capital at hand to make all necessary improvements, but, owing to the fact that the proprietors are behind the times, the help employed must work at a disadvantage. Such management can never be satisfactory to the intelligent workman. We have known of men making experiments to demonstrate that other methods were superior to those employed who were successful in their efforts, but they received no recognition from those who should be most interested, sometimes being told plainly that their ideas were impracticable when they knew to the contrary. The result of such management, or rather mismanagement, is that these men seek employment elsewhere, and often find it with other concerns who are engaged in the same line of business, where their ideas are taken advantage of, thus reducing the cost of production, much to the detriment of their former employers.

Competition in nearly all kinds of business is so great as to make it necessary to profit by every good suggestion made by men who have worked for years at certain trades and gained knowledge in this way, and those firms or corporations who ignore this idea will discover, sooner or later, that the law of the survival of the fittest is still in force.

MODERN AMERICAN MACHINE TOOLS.

By Oberlin Smith.

OF the early history of machine tools we know but little, although the use of such simple devices as the bow drill, for instance, extends back through many centuries, perhaps even to the time of Tubal Cain himself. Ages ago a tool something akin to our hand-lathe was in use, the spindle being revolved alternately in two directions by a cord attached to one end of a treadle or "lath" from which I believe the word "lathe" was derived. We find that this supremely useful machine, nearly in the shape of our present hand-lathe, was the "whitesmith's" chief dependence in the early part of the last century—although automatically-fed lathes for irregular turning, and even for screw-cutting, were in practical use previous to the year 1680. In this same 17th century, and I don't know how much earlier, clock-wheels were cut in "engines" which were evidently prototypes of our modern gear-cutters and other milling-machines. Real machine-work, as we know it, began however only when the use of the hand-tool was abandoned and the slide-rest was substituted therefor. Maudsley did this in England about 1794, but an excellent device of the kind had been publicly described and illustrated in France as early as 1772. These forerunners of the to-come developed later into a more comprehensive sliding carriage running over nearly the whole length of the bed, thus forming essentially the present engine-lathe, so-called.

This machine, together with simple vertical drilling-machines and planers, essentially the same in principle as our present ones, formed chiefly the machine-shop plant of the early half of this century. The lathes and drillers had been so gradually improved during their long course of evolution that little opposition to their use seems to have been made by discontented workmen. This was not the case with planers, which, when introduced about the year 1825, were mobbed and destroyed, in order that the old process of filing and chipping plane surfaces, at a rate perhaps forty times as slow, might be preserved.

These machines, though supremely essential to the then budding era of American engineering which has since astonished the world in its fruition, were not nearly so convenient as now, and were vastly lighter and more "springy" in construction. This however, was partly compensated for by their architectural beauty, especially in the main castings, which attempted to rival all the orders of Greek architecture, together with a modicum of Gothic, Moorish, etc., thrown in. Our superiority over the ancients was however duly manifested by a

gorgeous style of painting, which was calculated to make a really good rainbow blush with mortification.

Thus things went on, in this country at least, until something over thirty years ago when a new era began, chiefly instituted, as far as I can learn, by the Sellers and Bements of Philadelphia. A new type of machine was evolved, copied partly from the strong and heavy machines which had been developed by Whitworth and others in England, (but duly Americanized) wherein the aim seemed to be usefulness rather than ornament. Æsthetic considerations were not really neglected however, for in true art, as throughout nature everywhere, the use of proper materials, in proper forms, at proper places, produces the truest beauty, as well as the greatest utility. Foolish architectural frippery and multi-hued coloring were abandoned in favor of stiff "box-framing" of the simplest form, with the avoidance of external ribs, and with heavily rounded corners where practicable. Polished work was avoided to a great extent. Castings were made beautiful by their graceful curves and dead coloring of a shade natural to the material. More attention than ever was paid to strength and stiffness of the working parts, and to accuracy and durability of construction.

This English style of framing (or "Philadelphia style" as it was often termed in this country) was copied, with various modifications, until now nearly all our machine-tools are vastly different from what they were even twenty-five years ago, although the same general principles as were then in use are mostly embodied. One radical change made by the Sellers in planers, viz., the driving of the table by a worm instead of a spur-gear, has added greatly to the usefulness and smooth-working of that machine. Another more recent but very important change of practice largely developed by the same firm, has been in a high-speed "return-motion"—the ratio of this to the cutting speed being on small and medium sized planers as high as 8 to 1, while on very large machines they have succeeded in getting 4 to 1, thus saving a great deal of time, with a consequent increased production.

A most interesting question in regard to the use of machine-tools is: "what degree of exactness can be obtained in practice?" This is somewhat according to what standard of comparison is used, for there is no doubt that when Watt in 1769 managed to bore his 18" steam cylinder within 3/8" of round and parallel, he considered that he had achieved a great success, although later, when trying to pack the piston traversing therein "with putty and old-hat" to keep the steam at the right end of it, he might have begun to dream of improvements in boring-mills. We have obtained of late years somewhat greater accuracy than this to the almost total destruction of the old-hat industry, and moreover, a steady improvement is all the time

going on. So much is this the case that in some of the best lathes and planers now made, with special care in having uniform material and good workmanship, "scraped fits" have sometimes been obtained without any scraping; that is to say surfaces of moderate size have been made to so nearly touch each other all over as to be good enough for a working joint. Usually however the scraping off by hand of two apparently contiguous surfaces is necessary, the high spots on the work, after leaving the lathe or planer, being probably from .001" to .005" above the low spots, and having, undoubtedly, to a suppositious observer of microscopic size, the appearance of a fine rolling country.

As is well known, in the best modern practice the grinding-lathe and grinding-planer are used to supplement the ordinary machines using cutting tools, and by this means cylindrical, conical, plane and other surfaces are obtained of almost absolute accuracy, in regard to their roundness, straightness and flatness—that is where the work itself is stiff enough to retain the shape given it without perceptible distortion by gravity, etc. The reason of this additional accuracy is found in the fact that the emery-wheel which does the cutting moves at such a high speed, and has such innumerable little cutting edges, formed by the individual grains of emery, as to require no appreciable pressure to hold it against the surface of the work, on account of each little tooth taking such a very little bite. Thus the wheel does not spring away from the work and, on the other hand, the work and its supports do not spring away from the wheel—either bodily, or at individual spots by the bending of the work. This grinding process is now used for many ordinary purposes, and has even been adopted by at least one manufacturer, as a substitute for turning, upon such things as cast-iron gear-wheels, which, by the way, do not require any particular accuracy. A few years since this grinding process was only in its infancy, but was then considered necessary for the trunions of astronomical telescopes, as the accurate motions required therein had developed the fact that ordinary lathe-work was neither round nor straight.

It may be asked by the geometrician, who sees in an engine-lathe merely the embodiment of the beautiful principle of revolving a plane figure about an axis to produce a solid, why such lathe will not make a true cylinder, considering the fact that it is a mere copying device which should leave the piece of metal treated in it in any shape ordered by the brain of the maker and operator. To answer this question he must consider in the first place that all metal acts, when subjected to stress, exactly like a piece of india-rubber, only in a less degree. Granting that the lathe in question is itself accurately enough made and strong enough (neither of which is usually the case) we find several reasons why the path of the tool-point does not lie in the surface of

a true cylinder. One is the lack of homogeneity in the work, it usually being of different hardness at different places, crowding away the tool more or less in various spots as it passes around. Another reason is the original shape of the rough work, the tool being crowded away more where the heavy parts of the cut occur, and this action being repeated in a less degree in successive cuts, even down to the finishing one, the completed work thus being in some measure a copy of the rough material. Another reason lies in the bending of the work itself between its points of support, as will be easily seen in attempting to turn a rather slim shaft without other support than the lathe-centers at the ends, the middle crowding away from the tool and being very perceptibly bulged. Still another reason lies in the tool gradually getting duller from start to finish, having more and more tendency to be crowded away from the work as its cutting edge becomes rounded off. Still another lies in the fact that various vibrations are set up in the work and the machine, which are of course somewhat rhythmical, after the manner of a musical reed, but which, owing to irregular shapes, must form a good many interferences and give a confused result. These obviously tend, by the inertia of the parts, to make the tool cut more or less deeply in different spots. The geometrician would probably further ask why the tool could spring away if the machine was strong enough but this would only show that he had not yet mastered the india-rubber analogy before referred to.

In planing, milling and other operations the same conditions as have been described for the lathe are of course existent in regard to the planes and other surfaces which are being attempted. A particular exception to this action exists in such tools as drills and double-ended boring-cutters, which obviously cannot yield appreciably in respect to diameter. In regard to crookedness, however, these tools can fully hold their own as examples of the total depravity of inanimate things, the lack of straightness in long holes of small diameter being one of the most trying problems to be solved by the practical machinist.

In general, the improvements which have enabled so much more and better work to be done in our machine-shops than was done a quarter of a century ago, have consisted, to a great extent, in making the machines heavier and stronger and also much more convenient to manipulate. A greater gain, however, has been made by the use of special machines for special operations, as for instance axle-lathes, pulley-lathes, car-wheel-borers, etc. Such a machine is especially adapted to do some particular kind of work far better than any other machine could do it, and is not adapted for a lot of miscellaneous work so that there is a temptation to change it over for something else and not have it ready when wanted for its own special functions. A system like this

has enabled a 33" car-wheel having a hole about 5" in diameter by 7" long to be mounted, chucked, bored (two cuts) and dismounted in six minutes. Such work can be done at an average speed all day long of a wheel every 8 minutes, or 75 per day. It goes without saying that this work would take vastly longer if done in an ordinary lathe—probably from 10 to 20 fold, as work is carried on in jobbing shops.

Machines of this sort are constantly increasing, and some of them are very elaborate affairs, arranged to bore a number of holes at once of different sizes and in different directions, combined also sometimes with special facing and tapping apparatus. Such machines have been very successfully used for the frames of mowing-machines, for steam-pump and locomotive cylinders, etc.

Of late years another class of large machines not so highly specialized has come into use for drilling, tapping, boring, facing and milling a variety of objects suited to receive their services, such as the main frames of engines, presses and so forth, these machines being adjustable to a variety of positions and not limited to one particular size and style of work. Another special-general machine, so to speak, which has been chiefly developed in this generation is the turret-lathe. Than this there is perhaps no more beautiful example of the enormous gain in speed and accuracy obtainable by performing successive operations with specialized cutting-tools so arranged as to successively and quickly locate themselves exactly where they are wanted, and to definitely limit their own performance, without interference from the varying judgment and "personal equation" of the operator.

Another element in the cheapening of machine-work, more especially abroad than here, has been the introduction of hoisting and forcing machines for lifting, locating, putting-together and otherwise handling heavy pieces of metal. These valuable adjuncts to machinery plant consist chiefly of quick-acting cranes of various kinds, and also of hydraulic and other presses for assembling work. The recent introduction of the electric crane, which is so easily adaptable to almost every possible condition of force, speed and direction, marks almost a new era in handling machinery.

The use of accurate gages, micrometers and various other measuring and laying-out apparatus has also much facilitated modern work, as has also the use of various improved small tools, such as twist-drills, taps, reamers, etc., made by specialists on the "duplicate system." All these things have helped forward the standardization of various units which enter into the make-up of a complete machine. These units are themselves frequently made by regular manufacturers who do nothing else, and who therefore attain much greater cheapness and uniformity than could possibly occur with the individual machine-maker, who

could make but a few at a time, and with poorer tools. It is therefore the policy of the latter to purchase ready-made whatever articles he can find in the market, such as finished nuts, washers, bolts, keys, set-screws, dowel-pins, handles, shafts, pulleys, fly-wheels, gears, etc.; and there is an increasing tendency all the time to make up standard machinery in this way, as well as to unify the standards themselves.

In addition to the improved tools mentioned for building machinery in the ordinary way, there are methods of cheapening manufacture to an almost infinitely greater degree, where a great number of small articles are to be made in duplicate on the interchangeable system, as is the case with sewing-machines, pistols, watches, etc. These can of course be produced as cheaply as they are only by the very highest form of specialization, not only in the machines which turn and bore and mill the parts, but in the extensive use of locating and sizing tools, mostly consisting of jigs, templets, and gages. A comprehensive description of these potent factors in our modern civilization, second only to the printing-press itself, and using the same general principle of enormously multiplying the results of the original brain-work by means of sinews and muscles of bronze and steel, managed without fatigue by the cheapest form of labor, would require a volume, if not an encyclopedia, in itself. A single example of the cheapening processes in question may be seen in the case of a sewing-machine which can now be produced at a cost somewhere between $5 and $10, with better workmanship and more accuracy than could be obtained in an ordinary machine-shop, by an expert workman with his usual tools, for perhaps a couple of hundred dollars. The difference between these two methods is evidently the same as that between the work of the monkish bible-maker of the middle ages, toiling for years over a single volume, and the "lightning printing-presses" of the American Bible Society.

The future development of our machine-shops is difficult to foresee, but will, I think, be somewhat as follows. Our lathes will have very much larger spindles, both live and dead, the former, especially, being increased in diameter perhaps even three- or four-fold, where used for chuck-work, as we cannot afford much longer to go on practicing an outrageous sacrifice of time of machine and operator for the sake of saving a little journal friction. These lathes will have more convenient devices for reversing and changing feeds and will, like our most modern planers, be easily set to take a feed from 1/2" to 1" wide for certain finishing operations, etc. They will, too, be more specialized into chucking, center-turning, screw-cutting and polishing lathes, and will not attempt to perform any of these functions at will as much as is now the case, thereby nearly spoiling the machine for all of them. A chucking lathe with the spindle as large in diameter as is its average

work is no worse in respect to friction than is a planer with its table-friction moving at the same speed as the cutting. We shall therefore have 20" swing lathes with the large spindle-bearing 10" or 12" in diameter, instead of the pipe-stem affairs now in vogue. The frame-work of these lathes will of course be greatly increased in weight and stiffness—as will also the driving-gear.

Our drill-presses will follow pretty much the same lines and will be arranged with a reversing gear to facilitate tapping, left-handed facing, etc. They will be supplied with portable turret-tools, so that several sub-operations can follow each other without re-setting the work.

Our milling machines too will follow suit, having more convenient changes of feed, vastly stronger spindles, driving gear, etc. In all of these tools there will be a tendency to drive by worm- rather than spur-gearing, thereby easily applying greater power, avoiding undue vibration, and getting the smoothness of motion attained in the planing machines before referred to.

Our planers, shapers, slotters, etc., will be improved chiefly in the line of vastly greater stiffness. Especially will this be the case in the main side posts of the ordinary type of planer, which always have been, and still are, ridiculously weak in a lateral direction, making it (as is well known to every machinist) almost impossible to produce a vertical planed surface with anything like the degree of flatness that is attained in horizontal work laid directly upon the table. Why these posts should always have been made so strong fore-and-aft to take the direct stress of the tool, and have been made so extremely "floppy" in the other direction, has entirely passed my comprehension.

Our gear-cutters will, it is to be hoped, be vastly improved by making the indexing spindle four or five times as large in diameter as at present, with proper arrangements for driving the gear-blank to be cut with some clamping or chucking device so that it cannot slip around upon its arbor, as is now often the case, especially if the cutter is sharper upon one side than the other. That the spindle itself shall not yield torsionally between the working end and the index-wheel is of course sufficient reason for greatly enlarging it—and there is no possible objection. These spindles should also be hollow, with a large opening that pinions may be cut when made in one piece with their shafts.

The above are but a few instances of the radical improvements wanted. In general, it may be said that the most important change required is an average doubling or trebling of the weight, for a given capacity, of all sorts and conditions of machine tools. This use of what the writer has for some years past, in various publications, termed the "anvil-principle," in contradistinction to the "fiddle principle" now embodied in so many of our machines, and particularly in those

familiarly known as "Yankee tools," will undoubtedly do more to increase the production, as well as the accuracy of our machine-shops than any other one thing. This increase can be very cheaply purchased with cast-iron at its present, and probably future price, and with it will be purchased a freedom from vibration and a capacity for *heavy cuts* not now, I think, realized by most shop-owners. In regard to materials for machine tools the old stand-by, cast-iron, seems good enough for most purposes and very difficult to improve upon. Yes, even for lathe-spindles, although possibly it may not yet be quite orthodox to say so, there is probably nothing better than this metal, running in boxes of the same—*provided* the diameter is large enough.

Another radical change which the near future will probably see in our machine-shops, will be the abolition of shafting and belting, and the direct driving of each machine with its own electric-motor, simple pieces of conducting wire coming up through the floor, being substitutes for the tangled mass of timbers, hangers, shafting, pulleys, clutches, counter-shafts, shipper-rods and handles, ropes, belts and weeping oil-cups which are now the source of so much noise, inconvenience, danger and waste of power. Each machine handling heavy work will probably be provided also with its little electric-hoist acting as an auxiliary to the electric traveling cranes which can then traverse unimpeded the whole field of every ceiling.

Besides the improvements in *matériel* which we have prefigured, the *personnel* of our machine-shops will undoubtedly be greatly improved, not only by an influx of many more workmen from our technical- and trade-schools than we have hitherto-enjoyed, but by the moral and mental influence upon all the men of the cleaner and lighter electrically-driven, -lighted and -heated shops, which the future will bring us. These men will, by their more scientific methods, and by a more rigid system of shop government, learn to waste less time than now in laying-out and in setting their work, and will cause their machines to waste less time by the ridiculously light cuts and narrow feeds which are yet so prevalent, even in some of the best shops.

What the future may do in superseding entirely some of our present crude processes by some system of separating metals in proper lines of cleavage, instead of forging and casting the wrong size and shape for the sake of paring and scraping a good deal of it away in chips, it would be only chimerical to prophesy. It seems very certain that in this generation we must go on plowing and digging down to the finished surface of our work, as in the past; but potent factors which will enable this to be done more sensibly and at a considerably higher speed than we are accustomed to, will be by more metal plus stored-up brains in machines, and by more brains plus training in men who operate them.

A REVIEW OF AMERICAN MINING LAW.

By W. C. Wynkoop.

THE student of mining must recognize the important influence, either retarding or stimulating, which the laws and customs of different countries have exercised and are exercising upon the great industry. Mechanics and chemistry have had scarcely more influence upon its development and progress. But with respect to this branch of law, as it is with all others, there is wide difference of opinion, both as to what is or would be best. Perfection is far away.

It would be interesting to trace the development of mining laws in all countries, from ancient times, and show that their growth has been analogous to that of the common law, which is the development of the necessities of mankind into custom and practice. It is true that mining law can be found in the statutes instead of court decisions, or is supposed to be statutory; but the supposition is not entirely correct. Many of us have seen and can still find districts in the United States where the rigid application of the statute has appeared to be so inequitable that despite the instructions of judges, juries have refused to do their share toward enforcing it. And this recognition of equity in opposition to statute law has become so well known that custom has made a "higher law" or practically repealed the objectionable features of the statute in these places. But it is not necessary to go to ancient history to find material which is interesting to the American miner.

The first act in relation to mines in the United States was passed in 1785. As passed by congress, it was an amendment to an act which proposed to charge a royalty on bullion product. This part was stricken out, and one-third part of all discoveries of gold, silver, lead and copper mines was reserved to the government. Its impracticable nature was determined after the active development of the lead mines in Missouri began. In 1827 they were excepted from the act and in 1829 an act was passed providing for their sale to individuals, and the relinquishment of all government title to them. An act of 1846 provided for individuals getting title to lead mines in Illinois, Arkansas, Iowa and Missouri. Other acts were passed, as necessity arose, providing for the sale of mines in Wisconsin and Michigan. After the acquisition of California, the only law affecting title to gold and silver mines, anywhere west of the Mississippi river, until 1866, reserved them from sale. The result was that from 1850 to 1866, a period of 16 years, there was no law by which any one in the far west could get a title to a mining claim. Every man who worked one was a trespasser

upon government property. It was then that mining districts were formed, each one enacting its own laws and regulations, which were always incomplete and imperfect, but were supplemented by customs, which though different in different districts, were generally fairly well suited to the requirements of each case. In those days, when disputes arose, miners organized their own courts, where all differences were quickly settled without attorneys, court officers or expenses. The now indispensable and costly mining expert witness was not yet born. Our present mining laws may be said to have been evolved from those district laws, and are, perhaps, as near as skill can make them, a codification of the principal customs of those days. That they are not exactly equitable in all cases, is because geological conditions, which are closely connected with equities in mining, are so variable and unlike in different regions that probably human skill could not codify laws which would be justly applicable to all alike.

In the early days in the mining regions, the district laws almost everywhere made lode mining claims from 100 to 200 feet in length along a lode, in most cases only 100 feet, and restricted every man to one claim on a lode, unless he were the discoverer, in which case he was generally given two claims. Gulch or placer mining claims were even smaller. If they were in a narrow mountain valley, they were generally 50 or 100 feet along the stream, reaching from one side of the valley to the other. These district laws everywhere were based upon the theory that every man should have a fair chance at the mining wealth, and that no man should monopolize more than his share. At first there was seldom any law requiring a locator to perform any labor, or do any development on a claim, the presumption being that no man would take a claim except to work it. But this was soon proven incorrect. There were men who devoted their whole time to acquiring claims, for the purpose of selling them, and this struck the sense of justice as being wrong, so the universal rule soon became one to compel the performance of a certain amount of labor on each claim in order to hold it. The amount of labor required to hold a claim varied from one day per week, to practically constant work. Wherever there had been the most aggravated cases of "hogging" or monopolizing claims, there was sure to be a rule requiring the largest amount of labor. I remember hearing one rough miner-orator addressing a meeting around a camp-fire one night, who said "air, water, the earth and all its mines belong to humanity, and no man has any human or divine right to monopolize any more of any one of them than he can use." And this was a doctrine of use, which everywhere became popular, and which was enacted into our present statute regarding unpatented mining claims. The evil of one man

locating a host of claims in a district and holding them for speculation soon manifested itself, and was easily and effectively corrected by district laws, compelling stated amounts of labor to hold titles.

But there was a great annoyance and considerable friction arising from the marked difference in the laws of adjoining districts, and the frequent impossibility of telling in which district a claim might be located, and consequently under what laws it was held. The annoyance from these causes became so great that the enactment of a statute by congress in 1866, giving men a right to locate and obtain title to mines on the public domain, was welcomed. It promised uniformity where there had been confusion, and immediately upon its passage the district organizations were generally allowed to pass out of existence. Subsequently locations were almost universally made under the United States statutory requirements.

The old lode locations of 100 feet each were made under district laws framed by men who were almost all ignorant of the art of mining. The object in limiting a man to such a small part of a lode was to prevent the monopoly of too much ground by one man. There was a fear that nature had been very niggardly in her creation of veins, and that unless the size of locations was restricted to small dimensions there would not be enough to go around. It needed but a little experience to demonstrate that 100 feet on a lode was not enough ground to pay for any plan of mining development. On this account the act of congress of 1866 made the length of a lode location 1500 feet. But this act did not require locators to do any work annually, or otherwise, to hold their claims. When a man had made a location in compliance with the law, he was under no obligation to do anything more to hold it and retain its legal possession. The result was that the entire known lode bearing portion of the country was soon covered with locations made by men who were unable or unwilling to develop them. There were numbers of poor prospectors who each had from fifty to two hundred mining locations. The law made them impregnable in their dog in the manger position. The country was being stagnated and the mining industry was being rapidly stifled and killed by this act. The result was seen in the production of precious metals all over the west, outside of the Comstock mines. It was rapidly declining. In Colorado the production for the 14 years preceding the law of 1872 had averaged about $2,000,000 per year. Immediately upon the passage of that act it rose to $4,000,000 the first year, and has been increasing steadily from year to year till it now equals about $30,000,000 annually. One principal cause of the increase was this change in the law.

There were two very important features in the act of 1872, one of which has been beneficial, and the other, according to a wide-spread

belief, has been injurious to the industry as a whole. The act changed the rule under which locators could hold claims. It required that on an unpatented claim the locators must annually perform labor to the value of at least $100, and a failure to perform such labor forfeited all his rights, so that the claim became open to location by others. The result was that nearly all the thousands of claims held by men who could not or would not comply with the law, were relocated. Among the best mines in the west are many which were so relocated, and which, but for such a law, would yet probably remain unproductive prospect holes. To this feature of the law of 1872 can be credited much of the impulse given to mining, which in its turn has caused the construction of thousands of miles of railway, built populous cities and towns and added over a billion dollars to the permanent metallic wealth of the country. The main weakness of the "assessment-work" system is the uncertainty in determining whether the law has been rigidly complied with; but that is a question for the courts, as each case comes up.

The second feature of the law, about which there is a wide divergence of opinion, but which the majority, perhaps, believe has had an injurious or retarding effect upon mining, is the one which gives lateral rights to a locator. That is, where a locator has the apex of a lode entirely within the side surface boundaries of his claim, he can follow it downwards on its dip wherever it may go. During the past fifteen years lawsuits, involving the ownership of properties worth millions of dollars, have been constantly before the courts, often leading to bloody combats between rival claimants, but more often frightening capital from investment in mines or their development.

The law of 1872 is commonly supposed to have been framed to apply to typical fissure lodes in granite rocks, where the walls are well defined and the lode easily followed. As applied to such there was and is equity and fairness in allowing a locator to follow his lode on its dip to any depth. But the mining engineer knows that there are two distinct types of ore-bearing mines, though they may be divided into as many classes as the fancy of each man may dictate. These two types may for convenience be called regular veins and segregations. The first have well defined walls; their best types are found in granite or eruptive rocks. The segregations are generally found in limestone or other sedimentary rocks. They are irregular in shape, and are without well defined walls. The common opinion among working miners is that these segregations are not veins or lodes, within the meaning of the law, and that the law was never intended to apply to them, and cannot equitably be applied to them. The U. S. supreme court, however, has given a legal definition of a lode or vein which makes the law

applicable to segregations; but notwithstanding this, and the instructions of judges, juries often refuse to find verdicts for the apex claimants in cases where the ore deposits in conflict do not correspond with the ordinary miner's idea of what constitutes a vein or lode. It seems to be impossible for the average miner, especially if he has had his experience in mining in a granite or eruptive rock country, to conceive of a vein which has not two good walls. The great majority of such miners have formed their idea of a lode from the old geological idea that all were once open fissures in the crust of the earth, which were filled with ore after they were formed, and that nothing which does not correspond with this idea is a vein or lode within the meaning of the law. And they believe that this idea is purely scientific, and that any definition which does not recognize this mode of lode formation must be and is nonsense. The common idea was once well illustrated by what several jurymen in a celebrated mining case said to me. They refused to find a verdict in accordance with the instructions of the judge, and gave as their reason that "the judge knows more about law than we do, but he don't know as much about mines."

Probably very few mining engineers will to-day question the scientific accuracy of the definition of a lode or vein which the judges of the supreme court have given. It would be a bold man who would say that it is possible to draw a distinction between the different kinds of mines, with reference to their genesis, which the law could recognize.

There is an interesting fact connected with the drafting and passage of the mining law of 1872, our present law, now generally forgotten. The act as presented in congress was drawn by a commission consisting of Profs. Whitney, Clarence King, and Mr. Williamson, commissioner of the General Land office. Messrs. Whitney and King were geologists of established reputation. The act as drawn by them gave no lateral rights to locators. Miners were to be confined in their underground workings to the region embraced in the vertical lines of the boundaries of their locations. It was amended to give locators the right to follow their lodes or veins on their dip beyond their vertical side lines, when the apex of their lode or vein was wholly within their surface boundaries, the lode or vein running longitudinally with the surface location, and passing out of the end lines. Messrs. Whitney and King both predicted that the result would be to promote litigation, and their prediction, founded upon a geological knowledge of ore formations which legislators did not possess, has proven correct.

The feature of our present mining law which grants an absolute title to mines to individuals, absolved from all conditions, I am convinced is one which is wrong in principle, and injurious in practice.

One can now get a complete title to mining locations by patent, after which he can hold them forever, without compliance with any further conditions. The result is that all over the mining regions there are hundreds or thousands of patented mining properties lying idle and unproductive. There is only this check upon patenting, that it involves some expense, trouble and delay. It is a return, in some degree, to the conditions which prevailed between 1866 and 1872, when mine owners owned property which they could not or would not work, and which others could not work. There are many portions of the mining country whose prosperity and development are seriously retarded by the great number of idle patented properties covering them. Of course it would be impossible for the United States to enact any law now which would affect the title of these properties, and impose any conditions upon their owners except upon the basis of compensation to present owners. But it is not impossible to legislate for the future so that the laws would have a tendency to promote mining development instead of retard it. To do this the country has only to adopt a system analogous to that of other countries which are rich in the precious metals. In most others the governments never part with their their fee to mines; they allow men to work them under prescribed conditions. Often the only ones are that a certain amount of labor shall be performed each year, as our government now prescribes for unpatented mining properties. The purpose and effect of such laws is to induce the development of mines and the production of value, and at the same time promote the general welfare, as it is always promoted, by giving remunerative work to workers.

It is a question, too, whether our present mining law is not, in so far as it permits of the acquirement of title to mines without continuing conditions, a violation of fundamental principles of right. In the case of the utilization of water for irrigating purposes, the one who first appropriates it has the prior right, without cost, to its use, with which no one can interfere so long as he continues to use it. But when he ceases to use it himself others have the right to use it, which right continues so long as they continue to use it. The government here recognizes, so far as water is concerned, the principle mentioned by the miner-orator referred to, who declared that "air, water, the earth and all its mines belong to humanity, and no man has any human or divine right to monopolize any more of any one of them than he can use." In other words man can acquire an equitable right to that which he creates; but things which are a part of nature belong to humanity, and no man has any right to exercise control over them except as he makes use of them.

LIGHTNING AND LIGHTNING-CONDUCTORS.

By Oliver J. Lodge, F. R. S.

EVER since the time of Franklin, civilized man has has been accustomed to take some precaution against the destructive agency of lightning on his dwellings. A simple conducting-rod from top to bottom, stout enough to be safe against melting by any current it may have to convey, pointed above and rooted below, has been the protective agency more or less effectively employed. Not until quite recently, however, have the real conditions of the problem of protection been fully grasped. Franklin and his followers did not know of the possibility of electric oscillations. They did not think of a charged cloud as a great store of energy which somehow or other has to be dissipated; they thought, and the world until lately has thought, of a charged cloud as a reservoir of electricity which desires to come down to earth, and they supposed that the sooner and the quicker it was let down the better. The only thing they aimed at, therefore, was to make for it an easy path; and they thought that, by making one path easy enough, all other paths would be protected within a certain radius. They thought, in fact, that the path of least resistance would be chosen and that others would be spared. Consequently, wherever a lightning-rod failed entirely to protect; wherever a side flash sprang from it to other, and apparently very inferior, conductors; wherever gas was ignited by apparently quite detached and unstruck conductors,—it was customary to abuse the lightning-rod as having been badly erected or imperfectly tested. And since the portion underground was less conspicuous than the rest, and did indeed lend itself to poor workmanship more readily than the upper portion, it came in usually for the larger share of blame. Sometimes the blame was deserved, sometimes probably it was not; but we see now that in no case can a defective earth be held accountable for the whole of the mischief. The mischief lay in the laws of nature, or rather in the inadequate acquaintance with those laws possessed by the philosophers of the time.

When a spring, like a thin bar of steel clamped in a vise, is bent aside and released, it recoils to its old position, but in so doing it is apt to overshoot its mark and to swing several times to and fro, with rapidly-decreasing amplitude of vibration, before finally settling down. A load attached to the free end of the spring makes it oscillate more slowly, lengthens the period during which the oscillations last, and renders the existence of oscillation more certain. For, though they are common, they are not essential accompaniments to the release of

a spring. By friction, or by other forms of obstruction, one might arrange that the recoiling body should slide back quietly and slowly into its old position, without any overshooting and oscillating recovery. In other words, friction may cause the motion to be dead-beat, or, if excessive, may go beyond this and allow only a slow and gradual recovery like that permitted by a small leak in a vessel of compressed air. A massive or well-laden spring will, other things being equal, be able to maintain its oscillations in the face of a larger amount of friction than would be possible to a light unladen spring deficient in inertia. The recovery of this last would readily degenerate into a mere leak. Whether the recovery be slow or sudden, whether it be much resisted or almost free, in all cases the following statement holds good. The bent spring is a store of energy, which energy must all be dissipated before the recovery is complete. The energy is not destroyed, of course, but only dissipated,—that is, changed in form and transferred to other bodies; this indeed is what must become of any store of energy if it is to be released and made active. Whither goes the energy of our spring, and what becomes of it? Into sound partly if the vibration be rapid enough; into heat wholly if vibrations are checked altogether by abundant friction. In one peculiar case—if it be allowed to vibrate at or beneath the surface of a liquid—some of its energy may take the form of surface waves traveling out from a center, and traveling perhaps a long way before their energy is, in its turn, otherwise dissipated.

All these things are an allegory. An electrified body is a store of energy similar to the bent spring. The only difficulty about it is that, whereas in the spring it seems comparatively easy to lay our finger on the strained material and to point out the precise reservoir of the energy, in the electrical case it seems a little more mysterious and difficult. Something round about a charged body is certainly in a state of strain, and, when permitted, it will recoil as the spring did, and everything we have said concerning the spring has its analogue in electrical behavior; but that something is not the body, nor is it the air, nor is it anything in the ordinary sense material; it is, as a matter of fact, the ether. But, whatever it is, the discharge of the body corresponds to the release of the spring. The electrical resistance of the discharge-path corresponds to friction; the inertia of the spring, whereby it overshoots its mark and oscillates until sufficient time has been allowed for its energy to disperse, is called, in electrical language, "self-induction." But whereas, in the case of the spring, it was optional whether or not it should be immersed in a wave-propagating medium whereby some of its dissipated energy is accounted for, in the electrical case there is no such option; for every electrical event, as every other

event, occurs in the all-pervading medium—the luminiferous ether. When a discharge is slow, that is, much resisted, no oscillations take place, and the result is only heat. When the resistance offered to a discharge is moderate in proportion to the energy requiring dissipation, the whole of it is not got rid of in one swing, nor yet in two, but the swishing to and fro of the electric current, every swirl of which excites far-spreading ethereal waves, may continue for ten or a dozen, or it may be for twenty, complete swings. The rate of swing depends upon the capacity of the charged body and upon the self-induction of the discharge path—corresponding to the yielding quality and the inertia of the bent spring—but in most electrical cases the rate of swing is prodigious; it is comparable in fact to a million swings a second, more or less. The vigor of such swings as these, if on anything like an extensive scale, is hardly to be wondered at. The waves into which the ether is thereby carved are long and quick-traveling ones; they travel with precisely the speed of light. Light indeed in one sense they actually are, but not such light as can affect our retina. They are too gross, and fortunate it is for us that they are so, for during the instant they last their intensity is tremendous and would blind us.

When an electrified body of any considerable capacity is discharged through a path of high resistance, the recovery is comparatively slow; the current lasts an appreciable time and the only noteworthy result is heat. The heat may be of sufficient intensity to make wires red hot or to ignite gas and gunpowder. In those surroundings it is dangerous; otherwise it may be considered harmless. But when a considerable electrified body is discharged by a good conductor, the rush is sudden, violent, and oscillatory. Much less heat is then produced on the spot, but the noise and light called an electric flash is developed. A violent shock can be felt by an animal coming into line with it, and out into space go those tremendous waves of which we have been speaking. These waves may simply spread out further and further into space, becoming weaker and weaker as they go, by reason simply of the extent of territory over which their fixed supply of energy has to be spread; but on the other hand they may encounter conductors, and set up in them, by a process analogous to "acoustic resonance," electrical surgings of sufficient vigor to produce sparks, or even to do damage. All this is true of the release of any store of static electric energy—of the discharge of any electrified body. It by no means ceases to be true when the charged body is a square mile or so of cloud. Not only are all the effects spoken of likely to occur then, but they may occur with irresistible and overwhelming violence.

No longer now can it be held sufficient to lead "the electric fluid" down to earth by the shortest and easiest path, as a rain-shower may

be led down by gutters and water-pipes; no longer can a copper rod, even several inches or a foot thick and as long as you please, be considered a thoroughly efficient protection. Experimentally it can be shown that when a discharge takes place even down such a rod as that, sparks may fly from it to all conductors near, even to quite insulated conductors which lead nowhere. Into space and out again the electricity springs; and while it is thus flashing about the ramified conducting-pipes and wires of a building, woe be to the weak place, the explosive compound, or the gas-leak which it may chance to encounter. And even if side-flashes from the conductor itself do not happen to be dangerous in any particular instance, that is no safeguard against the furious though evanescent system of waves excited in the surrounding medium. These, as before explained, may excite sparks in perfectly detached and possibly distant conductors; and though such sparks may be far too feeble to knock out bricks and mortar, every one who has used an electric gas-lighter knows how feeble a spark is sufficient to ignite escaping gas. Moreover, when the discharge has reached the earth the danger is not over. A region of earth is for the moment overcharged, and the charge rushes away as best it may, splashing and surging up in many unexpected places. I have seen a house whose only important damage was in its cellar, and it stood near a lofty church-steeple properly protected. I have little doubt that the damage was done by a portion of a flash which had reached earth in the neighborhood and was on its way to dispersion underground. Some obscure fires may be due to such causes as these; more, perhaps, than have yet been suspected.

What then is the remedy? For important buildings, gun-powder-magazines and the like, there is no hesitation in the answer of modern science. They should be encased completely in metal, and no pipe or wire or anything metallic should be allowed to come through the walls or floor or roof without being itself metallically united to the metal sheathing at the place of perforation. That being done, and the sheathing being stout enough not to melt even at the place where a flash may happen to strike, everything inside is absolutely secure. No spark can be caused inside a closed metal cavity by anything that happens without. But inasmuch as the fierceness of a flash at its place of striking is very great, and such as few metal sheathings can with safety stand, it will be better to provide a projecting rod or two so as to tempt the flash to strike them; for then the melting of the first foot or so will be of no consequence.

But science goes a little further in the direction of ease and practicality than the above counsel of perfection. It asserts that an open metal netting is quite sufficiently safe, except as regards regions inside

but so near the boundary that their distance from the net is comparable to the width of its mesh. For ordinary houses, there is no need to be absolutely and mathematically safe. We never can fulfill such ideal conditions in this mortal life. If we should lock ourselves into caves in a copper mountain we might find there some lurking influenza germ capable of destroying us. For houses, then, a very open-meshed cage ought to suffice, and practically a wire along all the gables and down all the corners, with perhaps a few in between, especially on any prominent features, may serve well enough for all except for those who have an exaggerated notion of their own terrestrial value. Any metal serves equally well for the conductor: the cheapest and most infusible is best. Conductivity is ridiculously unimportant: durability is a much more serious matter. Points or projections to the sky are useful for the reason stated, namely, to take the violence of the direct flash at its point of incidence in a cheap and conspicuous manner. Earth connections are desirable to save the foundation, the soil, and the pipes therein from being knocked about. Sometimes one is inclined to recommend plenty of sky points, in the hope that a flash may be averted by their continual steady discharge. But I have lost faith in the discharging power of points when any large quantity of electricity has to be dealt with. Not until they begin audibly to fizz is any impression made on a large store of electricity, even by hundreds of needle-points; and, as soon as fizzy or brush discharge begins, small knobs, jagged edges, and the hundred other irregularities about a building are about equally effective. A smooth-polished dome is certainly not a desirable finial, but any ordinary roof-top should supply plenty of brush-discharging corners, especially if it is well connected to the earth by frequent iron wires. Circumstances sometimes occur, however, when the spears of an army would be incompetent to avert a flash; it is necessary to be prepared to meet it when it comes, and wise to admit the presence of a slight residuum of danger, even when every precaution has been taken to grapple with it effectively. Fortunately a building cannot often be thus dangerously struck without all its inmates and all neighboring inhabitants being aware of the fact; and I conclude that a desirable precaution would be to have cellars and floor-spaces and every place likely to contain gas-pipes or other inflammable material, inspected immediately after such an occurrence. Nor should the person in charge of an important building rest secure until a sufficient lapse of time has rendered it unlikely that any minute ignition may be gaining headway in some obscure and inaccessible region.

I have thus degenerated into practical aphorisms, about which there may be some difference of opinion. In all I say about what people should or should not do, I of course would be understood as

offering suggestions. Every one sufficiently instructed in the new facts of the science is competent to decide for himself what his procedure shall be: and many persons, like myself for instance, will probably be satisfied in feeling that they understand the circumstances fairly well and are not going to trouble themselves to do much to increase the safety of their houses. But then, with us in England, storms are rare and usually gentle. In South Africa, in the United States I suppose, at many cable-stations certainly, they are far otherwise. Hence the lightning-rod-man has been able to make himself a nuisance in such localities. With us he is scarcely known as a pest. The business seems to be in the hands of a few dignified firms who do not "tout" for custom. Long may it so remain: I trust that nothing I may happen to say will make it otherwise. It is, however, well to grasp thoroughly the conditions of a practical problem before setting to work to solve it, and if these firms can see their way to altering their procedure little by little, a better system of protection can be achieved without any revolution. Plenty of iron wire instead of a single copper rod—that seems to summarize what is required for ordinary buildings. For extraordinary buildings—explosive magazines, telegraph-cables, and telegraph-stations generally—a good deal more has to be said: and concerning telegraph-stations in particular there are a good many details to be gone into.

Some of my scientific statements may sound arbitrary, but they are not really so: they are not infallible of course, but they are based on good evidence. One of them which may sound rather revolutionary, and which indeed is rather revolutionary, being quite opposed to the views of Franklin and of Faraday, is the one which asserts that conductivity in a lightning-conductor is quite unimportant. One is not to go to the absurd extreme of supposing that therefore a rod may be made of glass or wood. Its meaning is that such difference of conductivity as exists between different metals is entirely unimportant. The only significance of conductivity is to avoid destruction by heat, and even in this matter, oddly enough, a bad conductor has certain advantages. A good conductor allows less time for the heat to escape: it may even get more heated than a bad one, because it can convey a stronger current. A non-conductor, for instance, whatever else might happen to it, would certainly never get *melted* by an electric current. As regards the easy conveyance of a violent flash, conductivity has nothing to say. The obstruction which an alternating or rapidly-varying current meets with is not the reciprocal of conductivity known as ordinary electrical resistance. It is not a bit like any resistance or anything analogous to friction: it is an obstruction of a totally different kind, closely allied to inertia.

A well-greased railway-truck may be pushed along by a boy when it is once in motion on a level line, but try to get it in motion, or to stop it, by a sudden blow, and, though you may knock the truck to pieces, you will not make much other impression on it. Electricity, in this respect, behaves like a substance with a great deal of inertia. Speaking popularly, to set all the electricity in a stout copper conductor into motion by a sudden force is a thing not to be done without violence. The force of lightning is indeed sufficient, but the violence of it is excessive, and, from every part of the rod subjected to lightning, electricity spurts as if a column of water were struck with a steam-hammer. This immense inertia obstruction, quite different from frictional resistance, and non-existent to steady and long-continued forces, has lately received the name "impedance"; and it is desirable that the cultivated world should get accustomed to the thing, whether by this name or by some other.

I spoke, a little way back, of inertia as being the cause of the prolongation of a discharge into oscillation. It is also the cause of the extraordinary obstruction which even a perfect conductor offers to sudden electromotive forces—an obstruction not many times less than that offered by a corresponding air-space, especially if the air be hot; so that when a discharge has begun to strike down a stream of hot air, for instance the current rising vertically from a factory-chimney, it is not easily diverted to a lightning-conductor projecting from the side of the chimney only a few feet away, but may prefer to continue its path down the air-column unless it is intercepted by some metal hoop or branch conductor thrown right across the mouth of the chimney.

In the light of such facts as these it is obviously absurd to speak of "areas of protection" or to think that one easy path protects all others in its vicinity. The fact is that to make an easy path is impossible; all paths offer a great obstruction to sudden currents, and many paths are therefore liable to be called on to convey a portion of the rush. Elaborate testing of the minute resistance which lightning-conductors offer to feeble voltaic currents is quite useless. It is worse than useless, because it is misleading. It is like trying to predict the course of an avalanche by trickling a pailful of water down a hillside.

Such is the outcome of some recent electrical investigations; and the result may be said to constitute the first distinct advance in this particular branch of applied electrical science since the time of Franklin.

RECENT ARCHITECTURE IN PHILADELPHIA.

By Prof. Warren P. Laird.

IN its architectural aspects the City of Brotherly Love presents one of the most interesting if not inspiring fields of modern American practice. For it contains some of the best as well as much of the worst of American architecture, in both phases of which is to be found, perhaps, a stronger expression of individuality than can be presented by any other large city in this country. So much has been heard of the badness of Philadelphia architecture, and so often have its artistic transgressions been held up for contemplation, that it has become the writer's pleasant duty to present to the readers of this Magazine the other side of the picture and to ask their attention to some phases of professional work which are in the highest degree excellent. This is done the more willingly because the critics would have us believe that, moral law to the contrary notwithstanding, one thing at least in this world is wholly bad, and that is Philadelphia architecture.

Many and grievous are the architectural sins charged against this well-meaning community. We are to believe that no principle of composition, no precept of history, no canon of taste nor law of æsthetics is respected by it. The critic exhausting other fields, turns again and again to this, always finding fresh material for his strictures, and never wearying of the apparently hopeless task of doing justice to the subject.

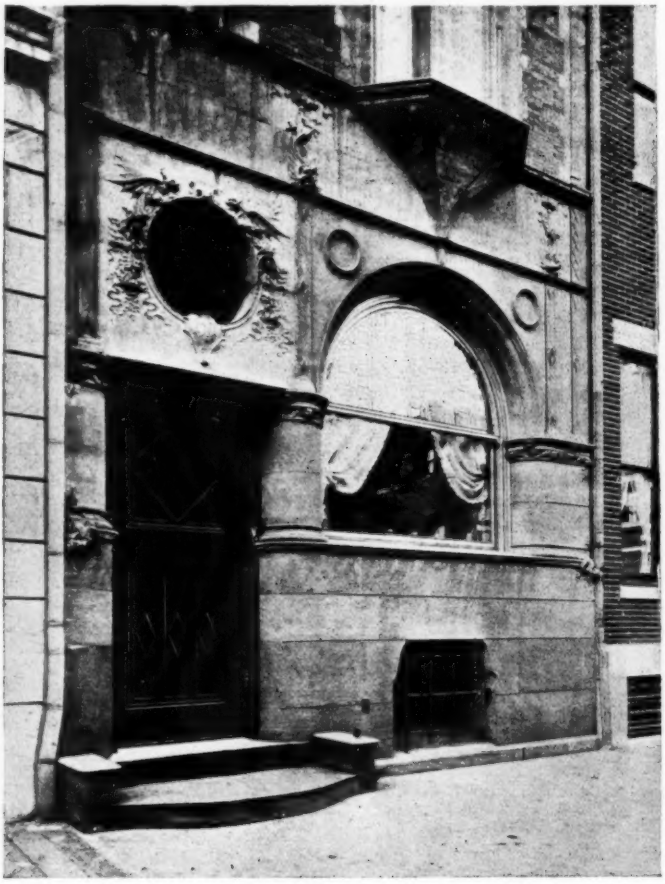
The critic is right—in the main. Yet he is wrong in one very important particular. Were it not for the cheering fact that he is usually blind in one eye, we would be forced to believe Philadelphia the architectural Sodom he paints it; but we know that his vision is restricted, and that he has not seen the good because of the bigness and boldness and frequency of the bad.

The strangeness of present characteristics in the building art of Philadelphia is not strange in origin. Yielding tardily to the widespread movement which has so completely changed the character of her sister cities during the past thirty years, and with a reluctance most becoming in a town of such conservatism, she has in a few years undergone a change that is scarcely less than a transformation. And to the fact that the change has been so sudden and so radical may be ascribed those characteristics that make the city an interesting study. For nowhere else are there such strange contrasts, not only between old and new, but between the different phases of new work.

HOUSE AT JUNIPER AND LOCUST STREETS.

TWO HOUSES ON WALNUT STREET ABOVE SEVENTEENTH.

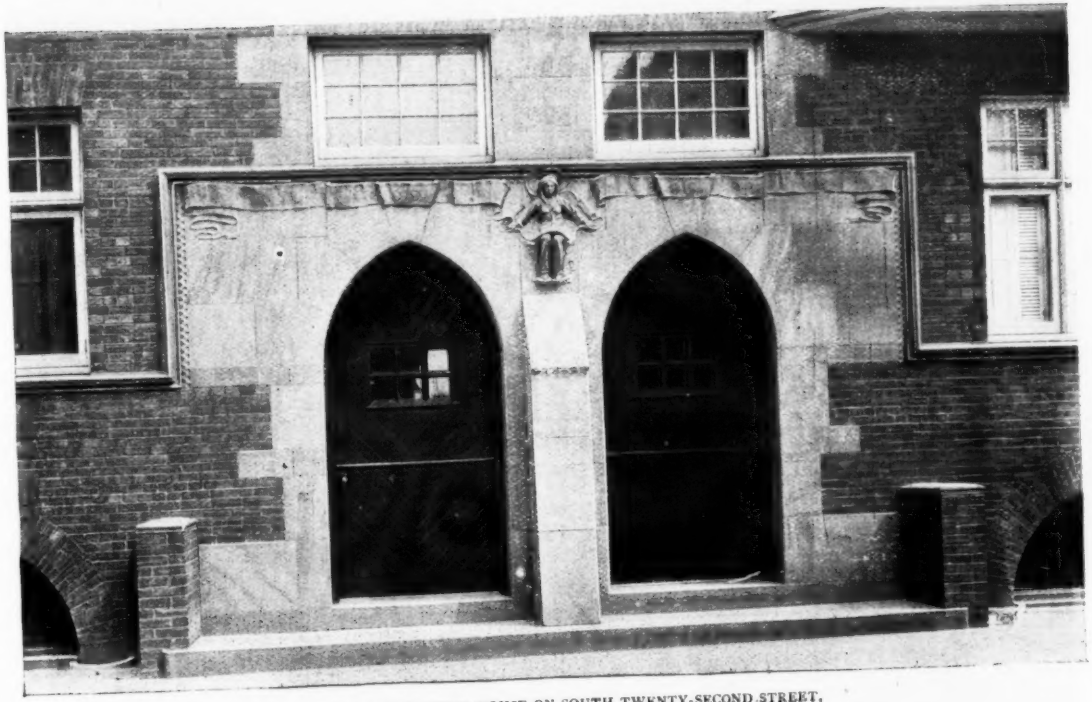
The ambition of the older Philadelphian, while it may have permitted him a house larger than that of his neighbor, never suggested to him that it look unlike it. In consequence, his city became proverbial



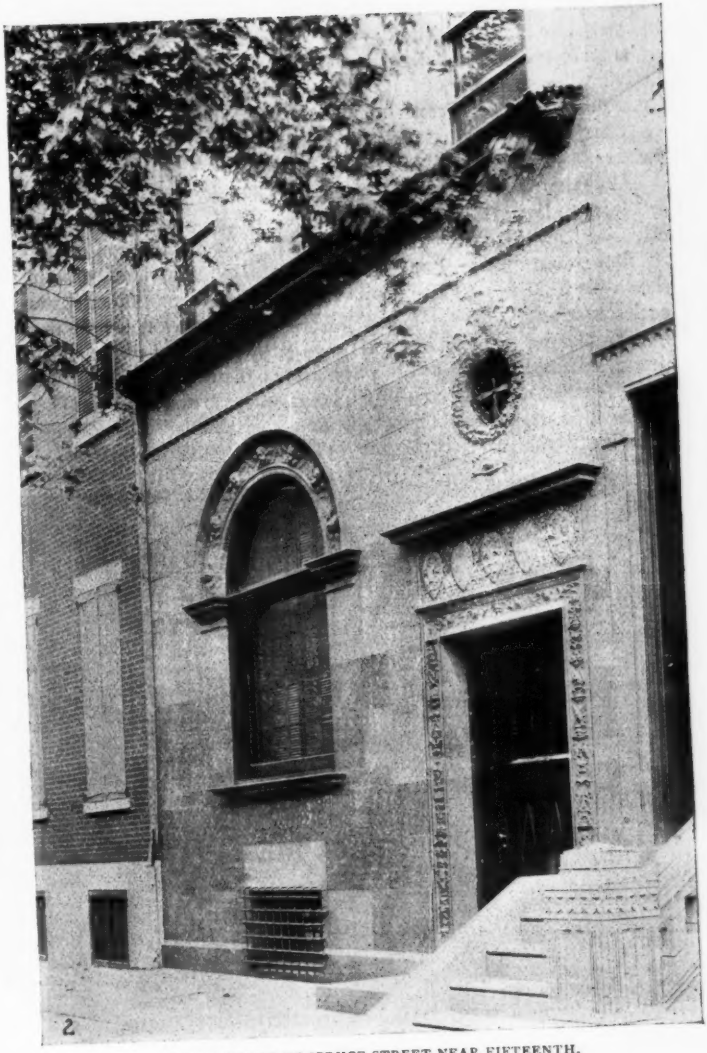
LOWER STORY, WALNUT STREET, NEAR SIXTEENTH.

for its monotonous uniformity—its miles upon miles of red brick fronts with white marble trimmings. But no surrender is so complete as that of the most obstinate fighter when once driven from his position, and Philadelphia conservatism has given way, as before a flood, to a feverish desire for novelty and variety. Scarcely can any two buildings be found to resemble one another; and in all this marvelous variety may be found illustrations of every stage through which American architecture

HOUSE ON WALNUT STREET NEAR TWENTIETH.



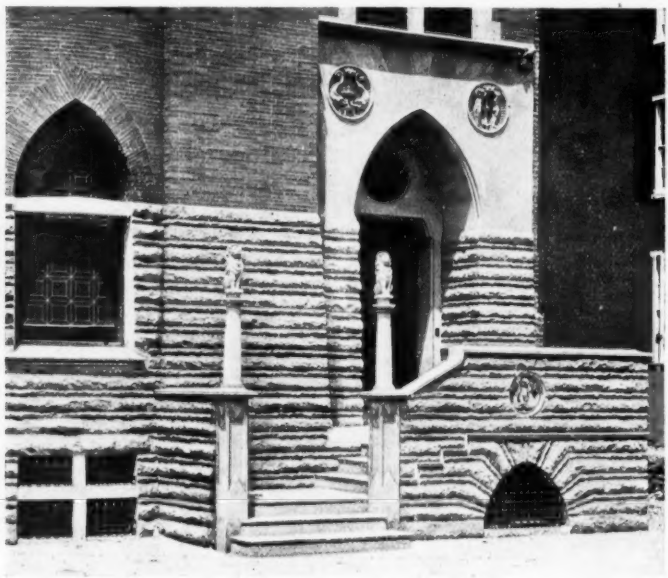
ENTRANCE TO DOUBLE HOUSE ON SOUTH TWENTY-SECOND STREET.



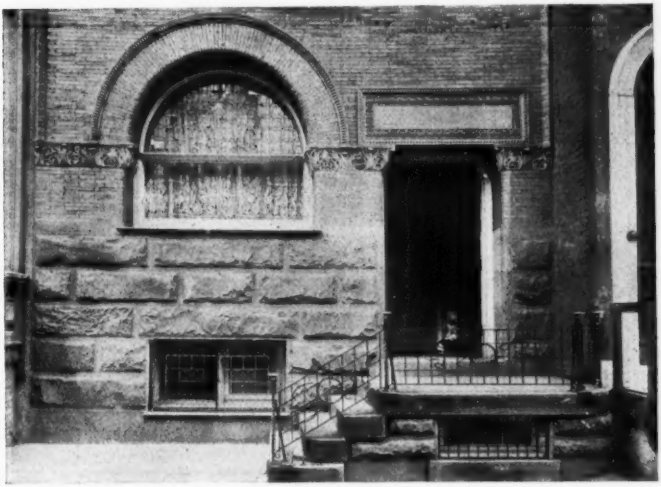
A NEW FRONT ON SPRUCE STREET NEAR FIFTEENTH.

has passed during recent years. Indeed, it may almost be claimed that Philadelphia is at once the most curious, the most typical, and the most instructive of American cities;—curious because of the strange medley of its more pretentious buildings, and their singular and often eccentric individualism: typical of American practise in its broadest aspects because of the absence of restraint and defiance of precedent shown by the great majority of its architects; and instructive because of its contrast, for no other American city has so wide a field of architectural error to offer in contrast to its works of real merit. Thus it is that Philadelphia architecture is more heterogeneous, more varied, and more open to criticism than that of any of the other large cities of this country.

More than in any other large city has the individual architect shown his hand in Philadelphia; and less than in any other has any coalescence shown itself among the separate influences that have made its architecture. But within a very few years a distinct movement has been manifested in the work of a small group of architects which, while not lacking in originality and individuality, has at the same time been marked by a uniform refinement, purity, and intellectual quality that places it entirely apart from the conflicting and misguided elements among



ENTRANCE, JUNIPER AND LOCUST STREETS.



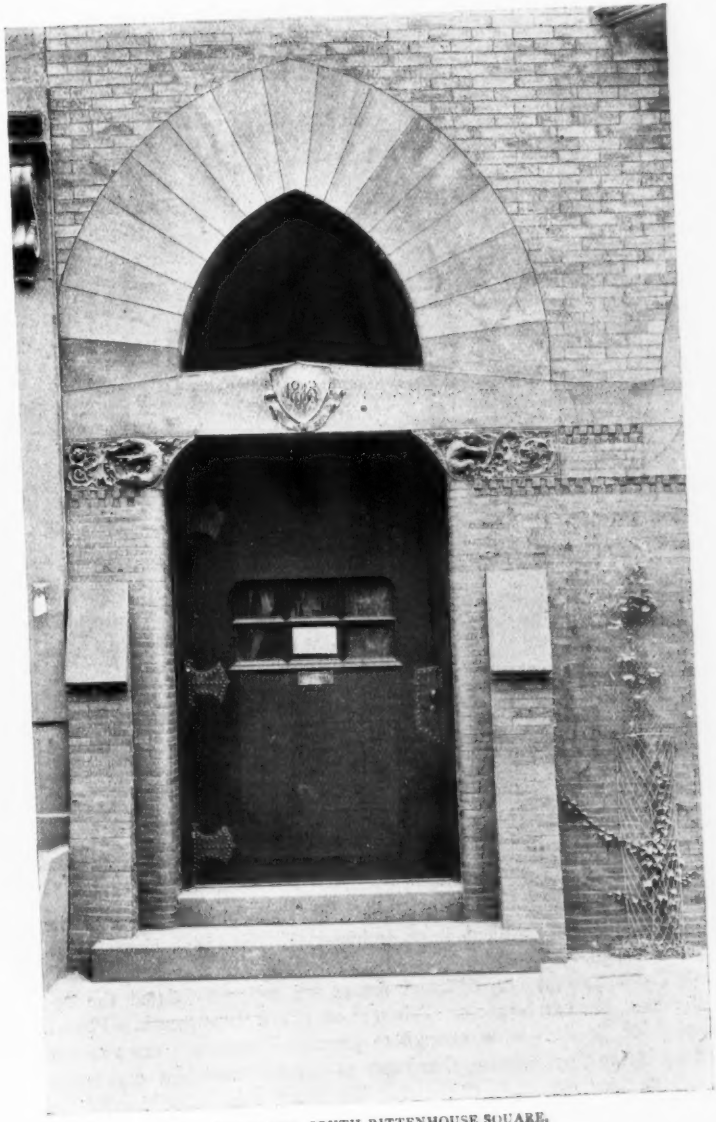
LOWER STORY, WALNUT STREET, NEAR TWENTIETH.

which it has forced its growth. It has not shown itself obtrusively, and is not to be found among the more conspicuous buildings; for here, again, Philadelphia differs from other large cities whose monumental architecture is frequently their best. Very seldom is it the case that prominence in a Philadelphia structure does more than make failure conspicuous. The best of recent work is to be found among the less pretentious buildings, and the greater portion of it exists in dwellings. It is noteworthy that the City of Homes should have begun its architectural reformation in this class of buildings. If, as we may believe, his home is the subject upon which the Philadelphian feels most strongly, then the seeds of reform could not have been more favorably planted.

The illustrations will be found to present broadly, the best of the recent work among dwelling houses. Several types are displayed:—the usual narrow city front, the corner house, the semi-detached house, and the suburban dwelling. All are conformable to the usual requirement of city house planning, and in none has advantage been taken of unusual conditions to secure given effects in external treatment.

The house at Locust and Juniper streets is a singularly successful attempt at picturesqueness in a city house. The result is attained by simple means, and the whole effect is one of quietness and restraint; yet an unusual freedom in play of line and surface is everywhere evident. A nice balance in expressiveness is maintained between the formal and dignified character expected in a town house and the in-

HOUSE ON SOUTH RITTENHOUSE SQUARE.

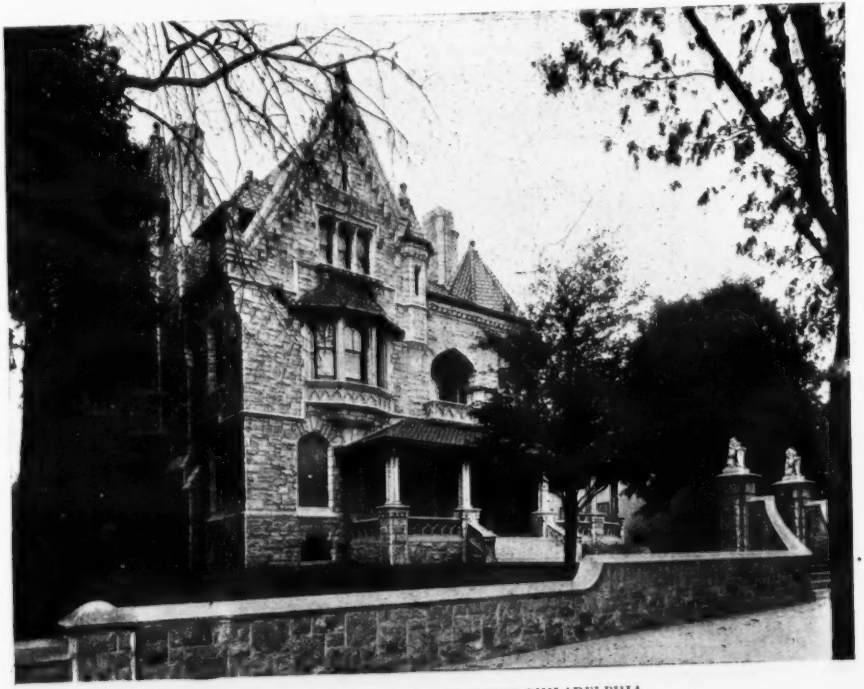


ENTRANCE, SOUTH RITTENHOUSE SQUARE.

HOUSE AT LOCUST AND SIXTEENTH STREETS.

formal and domestic nature of a house, and this solution of one of the most frequent of problems in an architect's practice is as charming as it is unusual.

Problems of a very different nature evidently confronted the designers of the two houses on Walnut street above Seventeenth. Placed upon lots scarcely wide enough to permit of more than one room at front in the upper floors, they seem to demand treatment expressing such an arrangement in the plan. To secure this a single *motif* has been taken as the keynote of the composition, in both cases, and a



HOUSE ON CHESTNUT STREET, WEST PHILADELPHIA.

HOUSE ON WALNUT STREET NEAR SIXTEENTH.

consistently simple division of the masses, vertically, adopted for its groundwork. Though differently treated in either case the Italian Renaissance has been successfully employed in both designs, not only in the detail but in the broad cornices, the *loggie* and the fenestration, indicating an earnest and sympathetic study of the style and an intimate knowledge of its spirit and its forms. In a problem of this nature, where the composition is resolved into few and simple elements, the adoption of a style which so readily adapts itself to a broad and simple treatment leaves to the designer a restricted field for the exercise of his skill, permitting little more than the proportioning of voids to solids

and the judicious application of ornament. Within such limits both these houses are admirably handled, that to the left being especially pleasing, while the detail in both cases is exquisitely wrought and applied with the greatest judgment.

Less pure in style, though carefully studied and full of character, are two other houses on Walnut street, one below Sixteenth and the other near Twentieth. The latter is an essay, in so far as features and details are concerned, in Romanesque, though treated with less vigor than usual in that style, as befits the outward and visible signs of a quiet domicile ; while the former has a pleasing ground story in Early French Renaissance. Neither of these houses is large and both are treated with quiet refinement.

Two houses in which the entrance has received distinguished consideration are those of a semi-detached house on South Twenty-second street, and a private dwelling on Spruce street near Fifteenth. In the double house the equal importance of the two doors is frankly expressed in a symmetrical treatment of simple forms and broad surfaces. The chaste simplicity of the composition, with its single piece of well placed sculpture, has a rare charm, augmented by the harmonious character of the arches, the reinforcing buttress and the draperies of the figure. Widely different in its inspirations and its frank deference to historic precedent, though equally sensitive to proportion, is the first story of the Spruce street house—an alteration. This charms us, not through originality, but by the fidelity of its details to their Italian prototypes and the almost equally clever adjustment of the several parts to each other and the whole, which the designer's sense of proportion has alone supplied and any failure of which would but have been exaggerated by the beauty of the details. No more perfect expression of refinement than that given in these two entrances is to be found in the architecture of Philadelphia.

The dwelling on South Rittenhouse Square will repay close study. Its northern frontage, like that of several others of the buildings under consideration, deprives it of that most lucid of interpreters, sunlight, and this disadvantage is further heightened by the light-absorbent character of its material, Pompeiian brick and red sandstone. It conforms closely to the usual conditions imposed by city building laws and is, further, unsymmetrical in internal arrangement, as indicated. These are the usual conditions and limitations of a city house problem in an architect's hands, yet the usual result is either no design at all or a very bad one, while this on the contrary, has been rarely successful. If we examine the design, accepting the conditions of height and narrowness as imposed upon the architect we feel that the vertical divisions are rightly placed and properly marked, the line being felt at once yet

being none too strong. The features are in themselves well proportioned, are expressive of the relative importance of the rooms they mark, and are correctly related to each other and to the general mass of the building. They moreover clearly express its unsymmetrical internal divisions. Simple to an extreme, the ornament is placed where it counts for most, the moldings giving a clear, firm line, and the carving accenting the points most justly demanding it.

Every detail and every line bears evidence of careful and loving study, even to the just perceptible curving of the oblique sides of the bay. Taken as a whole, while simple to the verge of severity, the composition is one showing rare sense of proportion and the greatest refinement and delicacy of handling. The style in which it is composed and the spirited individual treatment with which it is carried out to the last detail give the whole design a rare charm of novelty and freshness. Without a commonplace feature and yet without any evidence of a striving after originality for its own sake, this building is not only very original, but is an exceedingly fine piece of composition.

This entire group of houses, with others of their kind, stand apart from the generality of Philadelphia buildings, both for the sense of proportion and harmony displayed in their composition and for the refinement and purity with which they are treated. Whether historic precedent or its spirit and intent alone is selected as the keynote for treatment, the result shows a scholarly knowledge and a high artistic appreciation of both. In this spirit and this only is the salvation of Philadelphia architecture to be worked out.

But the list of our more noteworthy buildings is by no means complete without reference to the handsome structure now under completion at the corner of Sixteenth and Locust streets. The style in which it is conceived has been so often employed that originality or even freshness of treatment is perhaps impossible, but those qualities which it is so well calculated to express, dignity and elegance, are well presented in this instance. The composition would have distinctly gained in dignity and repose had the front wall been left without its rectangular projection, and the proportions, though generally excellent, are somewhat jarred by the too prominent sill course under the third story windows, and by an over heavy cornice. Although strongly suggestive of a well-known Boston mansion, it is yet possessed of sufficient individual excellence to entitle it to high commendation on its own account.

Another house worthy of special note is that on Chestnut street above Thirty-ninth, in West Philadelphia. Worthy, not for any single virtue of unity—of masterly grouping of parts, but because the ten-

dency it shows, in common with other work mentioned in this paper, toward the scholarly appreciation and skilful use of historic forms under the limitations of modern practice. This is shown more in the minor portions of the structure, whose forms and details are designed and executed with great truth and spirit. Although the design bears evidence of want of study, its main lines are well conceived and many portions yield happy effects to which any single view of the building can do justice only in part.

As it is manifestly impossible to show in a single illustrated article every example of the best recent work, the dwellings of Philadelphia are selected for illustration as embodying greater excellence than any other class of buildings. But the same general degree of excellence is found in a number of smaller club houses and store buildings, while distinct success has been attained in several churches, as for example in the exterior of the Tabernacle Church at Thirty-seventh and Chestnut streets. Philadelphia has produced much deplorable work and her tendency has seemed to the outside world to be altogether a downward one in matters architectural. But this is an error. So long as she is possessed of the influence of combined talent and taste which is making itself more and more strongly felt with every year, her streets will steadily improve in artistic character, and may at no distant time become attractive even to the visiting critic.

PROBABLE EVOLUTION OF THE ELECTRIC RAILWAY.

By Irving Hale.

THE development of the electric street railway has been so rapid, its acceptance by the public—except in a few of the largest and least progressive cities,—as the best system of rapid transit yet devised is so general, and the history of its triumph in the face of bitter prejudice and opposition is so fresh in the minds of all, that it would be a waste of time to discuss this branch of the subject.

The question of greatest interest to the public now is, "What will be the probable extension and limits of the application of electricity to railroading, and to what extent will it replace steam?"

It may be laid down as a law almost certain of fulfillment, that the development of the electric road will be a gradual evolution. This does not necessarily mean that it will be slow,—for that is a word supposed not to exist in the electrician's lexicon,—but that, like the growth of almost every other application of science and engineering, it will be a step-by-step process. This law was illustrated by every historical exhibit at the Columbian Exposition. In the chart showing the relative sizes of the Cunard ocean steam-ships from the *Britannia* of 1840 with a length of 207 feet, and engines of 740 horse-power, to the *Campania* launched in 1893, with its length of 600 feet, and engines of 26,000 horse-power, the gradation is almost as perfect as in a regiment on parade. In the exhibit of locomotives, from the John Bull and DeWitt Clinton to the famous No. 999 of the Empire State Express, with its record of 112½ miles per hour, few of these machines showed any radical departures in design or size from the types immediately preceding. There is no reason to suppose that this law will be departed from in the growth of the electric road, or to hope that any miracle of long-distance high-speed electric transit will spring in a state of perfection from a single brain, or become a complete practical success in a single year.

One of the first and most natural outgrowths of the electric street railway will be the application of electricity to elevated roads. In many respects this is an easier problem than the operation of surface roads, for the elevated structure affords an opportunity to conduct the current by a third rail, which cannot be satisfactorily insulated on a street track, and the motors are not exposed to their worst enemies, sand, mud, and water. In fact, some of the earliest experiments in

electric railroading were made on the New York elevated roads, and the lack of complete success in these trials was due, not to any inherent weakness in electric traction itself, but to the fact that they were made when no really successful system, even for street-roads, was in existence. Now that the success of the Intramural Electric Road at the Columbian Exposition has demonstrated both the practicability and the advantages of electricity for elevated roads, there is no reason why the electrical equipment of such roads should not make rapid progress.

On underground railroads the advantages of electricity over steam are much greater than on surface roads. Steam-power, with its attendant smoke and noxious gases, is manifestly unfit for such service, and electricity is practically the only suitable power now available. The success of the London underground electric road leaves no question as to the practicability of this system, and its extensive adoption in the great cities of the civilized world may be confidently predicted.

Another natural extension of the electric street railway is the suburban and inter-urban road. The former is an established institution. The latter is already in operation in several places and will gradually extend its field of usefulness. The advantages of electricity over steam on roads joining neighboring cities are evident,—avoidance of smoke and cinders, more frequent though smaller trains, and the ability to make the street tracks of each city and the road between them a continuous system, avoiding the transfers and delays at the steam railway stations. Beyond comparatively short distances, however, the ordinary 500 volt system becomes alarmingly expensive and the need of some longer-range method is apparent.

This brings us to the long-distance electric road, which, because it is a thing of the future and is fraught with such alluring possibilities, constitutes the most attractive branch of the subject.

At the outset of the discussion, the inquiry is naturally suggested as to what can be gained by substituting for the locomotive, in which steam power is produced on the spot and applied directly to its work, a costly and complicated system consisting of a stationary steam plant costing more than the locomotive, electric generators costing about as much as the steam plant and wasting eight to ten per cent. of the power in the process of conversion, expensive line-work or storage batteries (according to the system used) wasting another fraction of the power, electric motors on the cars exceeding the locomotive in cost and causing a loss of another ten per cent.,—all this for the doubtful privilege of running our trains by electricity. There must certainly be some strong compensating advantages to justify such a proposition.

In the first place, power can be produced much more cheaply in a stationary plant consisting of compound condensing engines supplied

by boilers of the most efficient type equipped with automatic stokers and grates for burning cheap slack coal, than in a locomotive where economy of fuel and labor must be sacrificed to economy of space.

Another advantage is the probable saving in repairs. The repair account for a locomotive, with its many rapidly moving parts and its overworked, poorly protected boiler, is a serious item. The electric motor with its single moving part, "iron-clad" method of construction, and thorough insulation of armature and field coils, is a very satisfactory machine from the repair stand-point, even when subjected to the trying conditions of street railway service, and in regular railway work, where it can be much better protected and cared for, there is little question of its superiority in this respect over the steam locomotive.

From an engineering stand-point, one of the most important advantages of electricity is the facility with which the weight of the car itself and its load of passengers can be placed upon the wheels to which the power is applied, thus utilizing this weight to give the necessary traction. The problem of applying steam direct to the wheels of the passenger car is a very difficult one and has never been attempted on a large scale. A separate locomotive must be used, and this locomotive must have sufficient weight upon its drivers to give the necessary adhesion to enable it to exert the required tractive force upon the train which it is pulling. The safe weight on each wheel being limited, the total maximum weight on the drivers is determined by the number of wheels to which the steam power can be applied without too much complication and rigidity of truck. The power of the locomotive is also limited by the size of boiler which can be mounted on its wheels, by the amount of water and coal that can be carried and by the capacity of the fireman to feed the furnace. Boiler, tender, fuel and water, while necessary for the operation of a steam locomotive and utilized in part for giving the required adhesion of the driving-wheels, are, in one sense, so much dead weight to be carried. All these difficulties and objections can be avoided if motors can be used requiring neither fuel nor water, applied direct to the axles of the car, and utilizing for traction the weight of the car and its paying load.

The electric motor, supplied from a wire with current generated in a distant power-station, exactly meets these requirements. It is not a difficult problem to mount a 200 horse-power motor on each of the six axles of two six-wheel trucks, carrying a car of large dimensions accommodating a hundred passengers or more, the load being distributed equally on the twelve wheels with every pound of motors, car and passengers utilized for traction, enabling this 1200 horse-power locomotive, which is a passenger car in itself, to haul as heavy a train of additional cars as could be pulled by a steam locomotive of the same

weight and power. It has even been suggested that motors might be attached to each truck of every car in the train. While this would be possible, it would involve undesirable complication in the connections between the cars, and more especially in the device for controlling the motors. The tendency in electric railroading will probably be towards more frequent and shorter trains, consisting of either a passenger-car-locomotive hauling one or two cars, or preferably of a single car of mammoth dimensions, equipped with its own motive power and avoiding all the objections of long loosely connected trains. For such service electricity is peculiarly adapted and is, in fact, the only known power suitable for the purpose.

It is needless to dwell in detail on the increased comfort of passengers given by a car of this description, with its freedom from smoke and cinders, perfect ventilation and unrestricted view. Anything which increases the comfort and luxury of travel will command a higher price, and higher price will help pay dividends on the greater investment required for electric equipment. It should not be concluded that the introduction of electricity will necessarily be accompanied by increased cost of travel. The tendency is toward a reduction of railway rates, and there is no doubt that travel, whether by steam or electricity, will be cheaper twenty years hence than now. But at any given time and under the same general conditions, the more perfect and comfortable service will command the higher price.

Watt is said to have remarked "I have what every subject of your Majesty wants,—power." Another thing which the people and especially the American people want is speed. Given a guarantee of safety, it is difficult to place a limit on the speed of travel desired by the busy man of the present age. Great expectations are generally entertained as to what electricity will do in this direction, and while there is no reason to expect a sudden leap to the marvelous speeds sometimes predicted, there are good reasons for the faith that electric power will render practicable speeds impossible with steam. The speed of a steam locomotive is limited by many causes, which either do not exist at all or exist to a much less extent with electric power.

One of the limitations in the steam locomotive is the allowable speed of the numerous moving parts, especially the piston and valves. By the use of larger drivers more ground can be covered with the same piston speed, but the steam pressure must be increased, and here again a limit is reached.

The pounding produced by the reciprocating movements of the many parts, which is injurious to machinery and track and doubtless enhances the danger of derailment, increases with the rapidity of these movements. In this connection must be considered the diffi-

culty of accurately counter-balancing such parts as the driving wheels, the slightest error in which causes a hammering at high speed which is extremely objectionable.

Train resistance (especially air-resistance and "concussion") increases rapidly with the speed. The power required, which is measured by the product of resistance and speed, rises still more rapidly, necessitating larger locomotive, greater boiler capacity, and grate surface, more coal, water and labor, and increased weight on the drivers to give the necessary traction. In all these directions a limit is soon reached.

The electric motor has but one moving part, the armature, and there is no difficulty in giving this a speed sufficient for any rate of travel yet contemplated. An armature being absolutely symmetrical can be perfectly balanced and its rotary motion has none of the objectionable effects of fast reciprocating motion, and doubtless involves less danger of derailment.

For the reasons previously discussed, the increased resistance due to high speed is a less formidable obstacle with electricity than with steam. This resistance can be greatly lessened by the use of a single large car containing its own motive power (rendered possible by electricity), which can be so shaped as to reduce air resistance to a minimum, and which, by the avoidance of numerous cars coupled together into a loosely jointed train, will greatly decrease "concussion"; there is no serious difficulty in equipping such a car with all the power required; the entire weight being on the drivers, there is no trouble in regard to traction; the boiler, fuel, water and firemen are in the distant station where there is plenty of room for them and no limitation to their capacity, amount and number, excepting that of expense.

After all, whatever the method of propulsion, expense is the principal consideration. The question is not "What speed would the people like?" but "How much speed are they willing to pay for?" Electricity, by decreasing the engineering difficulties which now make high speed impracticable, or obtainable only at enormous expense, will certainly pull up the stake heretofore supposed to mark the approximate boundary in this direction, and set it considerably farther on.

The advantages of electricity which partly or wholly compensate for its greater cost may be summarized as follows:

Higher efficiency or economy of steam plant; saving in repairs; utilization of weight of car and passengers for adhesion; greater comfort of passengers; increased speed.

The question of relative *economy* of the two powers depends so much on circumstances and is so uncertain in the present lack of experience with electricity in this service, that it is scarcely possible to

make a reliable comparison. The subject has been sufficiently investigated, however, to show that where the conditions are suitable, electricity will compare favorably with steam on the basis of cost of operation. Where this proves true, its probable gain in speed and indisputable advantages in comfort will certainly turn the scale in its favor.

Because electric power possesses so many attractive and advantageous features for railway work, it by no means follows that it is suitable for all roads. Like steam, it has its limitations, although in a different direction, and the conditions must be favorable to permit its satisfactory and economical use.

The chief limitation is that of distance. Long distance transmission is rendered possible by the law that if the voltage is increased in proportion to the distance, the cost of copper remains the same. The beauty of this compensation is marred, however, by the fact that, whatever the system employed, there is a limit to the voltage which can be satisfactorily controlled in apparatus and line. In the direct current system, this limit for railway service is not far above 1000 volts, and at this voltage the power stations would have to be located at such short intervals as to bar it from consideration for long distance railways. The multi-phase alternating system, which is so rapidly becoming the cynosure of all electricians, permits the use of low-voltage currents in generators and motors and (by means of transformers) very high-voltage currents on the line. While there are some technical difficulties in the application of this system to railroad work, there is no reason to think that they are insuperable or to doubt that it will greatly extend the distance over which roads can be satisfactorily and economically operated by electricity.

The storage battery is another "young hopeful" of which the public entertains great expectations. Its growth has been somewhat slow and disappointing, but this is partly due to the atmosphere of legal uncertainty by which it has been surrounded, and there is good reason to believe that before many years the storage battery will be a practical success for many kinds of work. For street car service its advantages over the trolley system, *provided it can be made equally practical and economical,* are generally recognized. For long distance railways it has several attractive features as compared with the trolley system. It would avoid the difficulties and complications of enormously high voltage and the technical difficulties previously referred to in the application of the multi-phase system to railway work. It would enable electric trains to be run on any existing track without the construction of line work. It would save the cost of "step-up" transformers at each station, primary line work, "step-down" transformers (which must be placed at intervals of a few miles, and each set

of which must have capacity to supply the train while on that section), and secondary line work from the step-down transformers, all of which, on account of the long distances between stations and large power transmitted, will be very expensive. It would enable the generating capacity of each station to be reduced to just enough, when worked continuously, to charge the batteries during the intervals between trains, while with the trolley system, each station must be large enough to operate the train or trains that may be on its section at any one time, although idle during the remainder of the day.

The natural conclusion from this comparison is that the trolley system will find its most favorable application on roads with heavy traffic where the stations can be placed at moderate intervals and given steady work, while for lines with less frequent trains, the storage battery offers the most hopeful and in fact the only economical solution.

When the storage battery can be made at half the present price, with twice its present life and capacity per pound of battery, and with a safe and fairly efficient discharge rate twice as high as the present limit, conditions by no means hopeless, it will become a very formidable rival of the trolley.

As the electric road is only six years old and scarcely anything has been done as yet towards the operation of long distance railways by electricity, it may be considered a little early to venture any well defined predictions on the subject. The indications are, however, that within five years electricity will be the generally accepted power for elevated and underground roads as well as for surface street car service; that in ten years numerous inter-urban roads from ten to thirty miles in length will be electrically equipped; that in twenty years some of the large railway systems enjoying the heaviest traffic will consider electric passenger service essential to their welfare; that, both for the convenience of the public and economy of operation, the tendency will be towards more frequent and smaller trains; that a maximum speed of 150 miles, and a schedule rate of 75 miles per hour will not be considered remarkable; and that within the life of the present generation we will see the present long train of loosely coupled cars with their restricted space, poor ventilation and light, imperfect facilities for viewing the scenery, and annoyances from smoke and cinders, give way to a single car of liberal dimensions, shaped on scientific lines to cleave the air at high speeds with minimum resistance, equipped with noiseless electric motors, free from the disagreeable products of the steam-locomotive furnace, designed to afford the passengers an unrestricted view in all directions, perfectly ventilated, lighted by electricity, and capable of a speed that will cover the distance from New York to Chicago between sunset and business hours next morning.

EDITORIAL

A Notable Departure.

THOSE of our readers who have followed THE ENGINEERING MAGAZINE since its early numbers, are in a position to share the gratification and just pride which we feel over the inauguration of the commanding feature which appears elsewhere under the caption "Review of the Industrial Press." The idea suggested by this title is not new to these pages, nor is the system of reviewing important publications in the least new to modern journalism. But in both method and matter this departure represents the final and full realization of an ideal toward which we have been moving from the beginning, and as such it may be confidently heralded as one of the most important departures yet taken in technical journalism.

In the first number of the Magazine, now nearly four years ago, there appeared a modest little department entitled "Our Exchange Table." It consisted of but two pages of large type, and was designed merely to suggest that we intended to give each month a list of notable and valuable articles appearing currently in our exchanges. In the succeeding numbers this department grew to three, four, five, and six pages in length, and by the end of the first half year it had taken on an engraved heading, entitled, "Editor's Exchange Table—An Index to Current Technical Literature." By this time, too, it was recognized on every hand as one of the most important features of the Magazine, and though abridged in size and imperfect in classification, it yet represented a well-selected list of articles every one of which was valuable. Meanwhile the various editorial departments supplied a great number of excellent reviews of noteworthy publications in every field of applied science, and we were often felicitated over the fact that these reviews, in conjunction with the Index, enabled the busiest of men to keep in close touch with practically everything of value in current technical literature.

But the end of the first year brought a crisis. The idea of supplying copies of the articles catalogued had been added to the scheme; the Index had grown to full sixteen pages of small type; and there was such constant demand for further enlargement, in both size and scope, that its publication as part of the Magazine seemed to be no longer practicable. It was accordingly decided to issue "The Technical Index" as a separate publication, and, by way of reparation for its withdrawal from the Magazine, to commit each of the editorial departments to the personal conduct of a distinguished expert—thereby imparting the added interest and weight of personal and professional responsibility to every utterance in our pages. In accordance with this plan the first number of "The Technical Index," as a distinct publication, appeared in April, 1892, and the issue of the Magazine for the following May appeared without it.

The change, however, gave immediate and unmistakable evidence of being a blunder. A fusillade of protests set in from every quarter, and the prevailing opinion was happily crystalized by one critic of high standing in the engineering world, who said: "You *may* make the Index a success, but you have robbed the Magazine of precisely that feature which I have always felt would ultimately make it the greatest of our engineering journals. To me it seems like removing a man's spinal column and then training him for an athlete." In the light of experience there was no answer to this argument. The Index was immediately restored to the Magazine, where it has remained ever since as its most commanding single feature—giving almost hourly evidence of appreciation by subscribers in every quarter of the globe.

But this restoration served only to renew and augment the demand for extension and enlargement. Every day was apt to bring its suggestion, and every suggestion served to emphasize the need for a scheme of presentation which, in addition to being definite, comprehensive and systematic, would also *give more information* concerning important publications, and give that information in concise, readable form. To recount all the suggestions to this end that have been considered during the past four years would be impracticable here. Suffice it to say that under suggestion, discussion, revision, and extension—a process of natural evolution—the original department of two pages has expanded into eighty odd pages with this number, and aside from being the most extensive review of technical literature ever before presented to the industrial public, we believe that the method of presentation is the most perfect yet devised by any one.

As indicated by the introduction to the Department, the aim is to give expert reviews of the *most important* publications of the month, in every field of applied science; to supply a complete index to *all* the leading articles published in the scientific and industrial journals of all the English-speaking peoples; and finally, through the Clipping Bureau, to furnish the original and full text of each and every publication so reviewed or catalogued. That is to say, as a review it does for industrial literature precisely what the *Review of Reviews* does so admirably for the political and literary world; as an index it is to the technical expert just what Poole's index to periodical literature has long been to the literary worker; and it is a long step in advance of these two celebrated publications, in that it affords an easy and inexpensive means of procuring all or any portion of the literature under review. For these reasons we commend it to our readers, unreservedly, as the most helpful aid that newspaper enterprise has yet placed at the service of busy workers in every department of technical and applied science; and we look upon its inauguration as the crowning epoch in the career of this Magazine—a career which we believe is without a parallel in the annals of technical journalism in point of its immediate, substantial, and enduring success.

Industrial Discontent.

THROUGHOUT the civilized world the laboring classes are manifesting a painful discontent with prevailing industrial and commercial conditions. The intensification of this unrest seems to many profound observers of events a menace to the social structure. In no country, except perhaps Russia, has this feeling been more pronounced than in the United States. But in Russia, kept down by a powerful military force and rigorous police control, it has not been able to assume openly the threatening aspect it has lately presented in the United States.

With some it is held that what has been called our "marvelous progress" has been a forced march toward a complete overturn of the institutions founded by patriots who achieved American independence, and who, as they truly believed, framed the most liberal form of government that has yet blessed the human race. Those patriots and statesmen, however, foresaw many political and social dangers to be shunned, and in their speeches and writings set up beacons of warning. They were not sure that what appeared so fair at its dawn would be a political day without either clouds or storms. But, though they viewed the future with anxiety, they hoped and trusted.

While the government was yet young,—while America was ruled by Americans in feeling as well as in name—it seemed indeed a paradise as compared with older states. Extremes of either wealth or poverty were rare. Villages were centers of prosperous industry, and every one who wanted work could find it. Class distinctions hardly existed. The lawyer, congressman, physician, merchant, clergyman, teacher, mechanic, farmer, and the man who could live on his income, came together on one social plane, sharing a truly democratic spirit. Our legislative halls were then filled by representatives above the suspicion of corruption. The period of

rings, lobbies, and combinations of money power to influence legislation had not arrived. The vast public domain had not been given away to foreigners or placed on sale for the benefit of greedy speculators. "Uncle Sam was rich enough to give us all a farm." Politics had not yet become a business to be pursued for amassing wealth.

The change which has been wrought during half a century has been in itself almost a political revolution. If men like Webster, Clay, Jackson, Jefferson, Franklin or Washington now exist, they are not politically known; because men like these, who cannot be controlled by some commercial interest or some political ring, are not wanted in office by those who can control nominations. A very large proportion of the population is a foreign element whose customs and education are not adapted to assimilation with the spirit of American institutions, as the latter existed in the first half of this century.

The best part of the public domain has been bestowed, not upon American citizens, but upon the needy of other lands, or has been purchased by home and foreign capitalists purely for speculative purposes. The trades that once supported in comfort multitudes of independent mechanics, in business for themselves, have practically disappeared. The goods and wares which these once produced are now supplied by enormous manufacturing establishments through the aid of machinery. Instead of being thrifty, independent workers on their own account, mechanics are now, with few exceptions, reduced to the condition of wage earners, their small incomes dependent often upon the state of commerce or the will of the master who gives them leave to toil. The agricultural part of the population find their burdens steadily increasing. Retail merchants with small capital are gradually being crowded out of business by huge bazaars that are rapidly absorbing retail trade; and the merchants thus driven from trade are fain to become wage earners in the larger establishments.

This, then, is the condition of affairs which confronts the industries of the United States. While the number of employers is diminishing the number of those who must live, if they live honestly, upon their wages as employés, constantly increases. It is this tendency, together with the shameful robberies of the people and defeat of popular will effected by political organizations, that, more than accumulation of wealth in the hands of a few, is putting an alarming strain on our social structure.

The wage system was a great step in civilization beyond serfdom; but it does not wholly liberate men from dependence upon the will of others. The masses of men, reduced to the condition of wage earners, will not rest content without some security against total loss of employment or the reduction of earnings to the point of bare subsistence.

Machine work has replaced manual labor till the latter finds itself subordinate. This is a new condition that has come upon the human race suddenly, and has found the world unprepared to meet it. It is certainly not compatible with true civilization that great numbers of men, women, and children find themselves on the down grade toward increased dependence upon public charity. Remedies must be found.

But the industrial revolution wrought by invention must be accepted. We cannot discard machinery and go back to manual labor for the supply of either old or new wants. We must take social materials as we find them, and out of present conditions strive for a happier state.

The improvidence with which we have squandered the public domain, unexampled in history, handicaps us at the start. The equal imprudence with which we have been admitting immigrants to the political family without regard to qualifications for citizenship, and granting rights of citizenship to all so admitted after a merely nominal sojourn here, with all the evils this system has entailed, handicaps us still further. The social problems presented are by no means easy of solution. Those who shall grapple with them need to be men of the largest mental caliber, soundest principles, and broadest sympathies. It

is a hopeful sign of the times that both foreign and American journals, hitherto confining themselves to purely technical subjects, are beginning to open their columns to discussions of social aspects of industrial progress. Henceforth, until industry emerges from its present troubles, such discussions will take first rank in popular interest.

An Abuse of the Patent Law.

WITHIN the past fifteen years, there has grown up in this country a systematic and pernicious practice of patenting a certain class of so-called inventions which are in fact nothing more than obvious mechanical or engineering expedients, and which involve in their production nothing whatever beyond the ordinary intelligence and skill which every experienced craftsman must almost of necessity possess. The electrical industries especially have suffered greatly from the numerous attempts to appropriate as many as possible of the fundamental engineering expedients and methods essential to the economical production and distribution of electrical energy on a large scale. It has long been predicted that if ever one of this class of patents should come to be passed upon by an intelligent and clear-headed judge, who had sense enough to perceive that the mere application of a well-known principle to the control or distribution of electricity instead of steam, gas, or water, did not necessarily call for the exercise of inventive skill, this practice would be likely to receive a severe check. The occasion has at length arisen, and fortunately for the industries of the United States, the man for the occasion was on hand. In distributing gas to consumers by means of mains laid along the streets, it has been known for half-a-century past that when the number of consumers on a particular main had become so great as to cause inconvenient fluctuations in pressure at times of maximum and minimum consumption, the obvious remedy was to lay an additional pipe connecting the region of minimum pressure with the source of supply, and to so proportion the entire pipe system that the fluctuations of pressure would take place in this supply pipe and not in the consumer's mains. The same thing was equally well-known in respect to systems of water-distribution. When it came to the question of distributing electricity on a large scale, precisely the same problem once more presented itself, and inasmuch as the mathematical formulæ for computing the capacity of conductors and the fall of pressure in the case of electricity are identical with those applicable to fluids generally, and had been known to be so for generations, nothing remained but for the engineer to apply these same old formulæ, and thereby determine the arrangement and relative capacity of his electric conductors. Nevertheless a patent was taken out in the name of a well-known inventor, purporting to cover any such organization of conductors for distributing electricity in which the capacity of the supply conductors or feeders is less than that of the mains! It is not a little surprising that the Patent Office should ever have granted such a claim, and it is still more surprising that a circuit court should ever have been found to sustain it; but as the French say, "It is the impossible that happens," and so it was in this case. Now, after years of tedious, annoying, and costly litigation, Judge Acheson, of the Circuit Court of Appeals, in a most able and luminous decision, has swept away at a blow the entire accumulation of sophistry and special pleading with which it has been attempted, not without a considerable measure of success, to bolster up this most objectionable and indefensible class of patents. In his opinion, reversing the decree of the lower court, Judge Acheson says: "In truth, the feeder and main system of distribution came naturally, in the ordinary course of incandescent lighting, as and when needed. . . . The proper proportioning of the two parts of the combined circuit involved only the exercise of the common knowledge and skill of the electrician. . . . The plan of electrical distribution covered by the claims in question is not 'the creative work of that inventive faculty which it was the purpose of the Constitution and patent-laws to encourage and reward.' To sustain these

claims would be to sanction a monopoly in that which belongs to the public."

The importance of this righteous decision lies not so much in its application to the particular patent under consideration, although the importance of this is by no means to be underrated, as to a great number of even more indefensible claims of the same general character, which have succeeded in passing the scrutiny of the Patent Office, and under color of which the public would in due time have been called upon to pay most onerous tribute in the guise of reward to worthy inventors. Henceforth systems for the distribution of electricity, like systems for the distribution of other fluids essential to the comfort and convenience of man, will in all probability have to be exploited on their own merits, without the assistance of a patent monopoly. F. L. P.

Architectural Ideals.

AN exalted architectural ideal is a noble thing. It stimulates its creator and ennobles the men who may have the privilege of enjoying it in its completed form. The noblest buildings of the world are the visible material expression of architectural ideals. They are great thoughts expressed in stone or brick or other building substances. Given form that is practically imperishable—more lasting, indeed, than that of any other art—they have stood, many of them, as proud records of some of the finest conceptions of mankind. Men of all subsequent ages have bowed down in admiration before them, found inspiration, happiness, faith, joy, satisfaction in them; been better for their influences; been spurred to greater effort that they might themselves profit by the splendor of the thought displayed in these superb monuments. The rhetorician, astonished and overcome by their grandeur, may lapse into error in singing their praises perhaps, but his interest may not be harmful. Upon the architect the effect of such work is incalculable. Who would not exchange his most valuable possession—life itself, perhaps more than that—if he had made the Parthenon, the cathedral of Paris, the dome of St. Peter's?

We do not know that we should like to follow the full extent of the architectural mental operations of previous times. The great temple at Karnak grew year by year, was added to by Pharaoh after Pharaoh, but we cannot say just what conception the man had who began it, nor on what scheme the final great series of buildings was carried out. But whether this building was conceived, on general lines, as an entirety at once or not, the final effect was single and united. The group of buildings—for it is a misnomer to speak of them as a single structure—illustrated a great idea in a great manner. The medieval cathedral, though its growth extended often through centuries, grew along certain general lines determined at the outset. The cathedral of Paris was not begun until the idea was thoroughly mastered at the beginning. This once determined upon, minor variations were of small moment. The ornament could be changed at will; the fundamental lines of the building must be fixed and definite to permit the idea to be carried out. So the beginners of these buildings, and all others of their class, started out with an architectural ideal, which they felt to be so great, whose truth was so real to them, whose beauty so marked, that they had amplest confidence that the structure would be completed on very much the lines they laid down—that the lesson they sought to teach would be taught.

The modern architect, with all the world's noblest conception in architecture before him, may well aspire to the creation of architectural ideals that will place him in the same category with the world-acknowledged masters of their art. And an architectural ideal being a noble thing, it is not less noble in the breast of the modern architect than in the heart of the greatest builder of the past. It is as good and noble now as it ever was. But is it wise? Is it profitable? Is it useful? Architectural ideals are too great things to be hastily destroyed. The world is much too sordid. This sordid world can ill spare a noble thought of any sort, and a noble architectural thought least of all. But the conditions of modern architecture

are not conducive to the creations of architectural ideals as they were in the past. Civilization that has brought so many advantages (and curses) to humanity has so changed life and men that what were once ideals in architecture are so no longer. The Parthenon represents an architectural ideal both for our own age and for that in which it was built; but a modern Parthenon, and an actual copy most of all, would be a simple curiosity, without the smallest living interest. This day and generation is concerned with other things and other buildings; and things and buildings of so new a type, of so strange a meaning, and of so novel a purpose that the old architectural ideals need to be transplanted into a totally new language, transformed into other forms, used in other ways, before we can have an architectural ideal that is at once illustrative and emblematic of our own time. This may not always be pleasant work. It is easier to create new ideals on old models than to wholly transform and rejuvenate them. Nor is this all, for this is a most unidealistic age. Though culture and civilization have had their most splendid flower in this age, the age is not kind to ideals. The architect who sets up lofty standards before him is likely, sooner or later, to find that he has been depending upon a broken reed. The modern atmosphere badly agrees with ideals, and the sooner architects admit this fact, the sooner they cast off traditionary ideals and take up the study of the modern, the better it will be for their art and themselves. Young men, starting out in life with a large stock of ideals, need not be too careful of them. Sooner or later they will all be broken. Unless their actual relationship to modern life is discovered in the process the result is likely to be painful. An unidealized architect, with nothing to fill the place of his lost hopes and aspirations, is a heart-rending spectacle. B. F.

New Trade Catalogues.

In this age of rapid advancement in the technical arts, coupled with the possibilities of large financial rewards for individuals who may happen to make valuable discoveries or who may be placed in charge of important constructions, it is only natural that the leaders in the material progress of the world should not be writers of books recounting their work. At best technical books have but a limited sale, with small returns in money for their authors. At the same time, the promoters of valuable inventions or devices, in order to attract buyers, have gone to great expense in preparing descriptive catalogues, until many publications of this class possess a real value as a record of the latest progress in their respective branches of art. Indeed, no mechanical or industrial library to-day can be complete without a file of catalogues of the leading manufacturers of machinery, tools, and appliances, in many of which are embraced important facts not yet embodied in any volumes in the booksellers' trade. One important reason for the non-appearance of books in certain arts is the probability that even while a work is going through the press discoveries may result to render some part of it obsolete. An illustration of this tendency is shown in the case of a company organized recently to manufacture a certain new bicycle-tire, which it was found advisable to discard on account of another invention made while advertising matter for the first tire was being prepared. Since trade catalogues can be produced with more facility than books having real value, the former can be the more easily kept up with the times, and thus be made to record more promptly the improvements constantly in progress. These considerations apply to trade catalogues with respect to their usefulness in the technical library, in addition to the primary value of the carefully-prepared catalogue as a guide to buyers in the trade which it is intended to reach. Thus there is a double reason for incorporating in our department of "New Books of the Month" a record of the catalogues produced from time to time by the leading firms in the lines of manufacture allied to the scope of the Magazine. It may be stated, in general, that the catalogues here noted are intended for free distribution to those who may be entitled to them.

REVIEW OF THE INDUSTRIAL PRESS

WITH AN INDEX TO THE LEADING ARTICLES PUBLISHED CURRENTLY IN THE TECHNICAL JOURNALS OF THE UNITED STATES AND GREAT BRITAIN.

THE purpose of this Department is, (1) to give concisely written, expert reviews of those articles of the month which are deemed of most importance; (2) to supply a carefully classified Index to *all* the leading articles published monthly in the scientific and industrial press of the United States and Great Britain, and (3) to afford, through our Clipping Bureau, a means whereby the full text of any one or more of these articles may be immediately procured at the minimum of cost and trouble.

The entire Review is conveniently classified into the recognized divisions of applied science—everything pertaining to "Architecture and Building" appearing under that heading, while "Civil Engineering" is given under that title, and so on alphabetically throughout. The titles, addresses, and initials of all the journals regularly reviewed are given alphabetically below, but in the body of the Index only the initials are given. Other abbreviations used are, Ill=Illustrated; W=Words.

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A An.... American Analyst. *f.* $1. New York.
A Ar.... American Artisan. *w.* $2. Chicago.
A & B....Architecture and Building. *w.* $6. N. Y.
A B D....Architect, Builder and Decorator. *m.* $2. Minneapolis.
A C J....Am. Chem. Journal. *b-m.* $4. Baltimore.
A E R J..Am. Eng. and Railroad Journal. *m.*, $3. N.Y.
A G.....Am. Geologist. *m.* $3.50. Minneapolis.
A G L J..Am. Gas Light Journal. *w.* $3. New York.
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A J R A..Jour. R'y. Appliances. *m.* $2. New York.
A J S ...Am. Jour. of Science. *m.* $6. New Haven.
A M.....American Machinist. *w.* $3. New York.
A M & I W.Am. Man. and Iron World. $4. Pittsburg.
Am S.....American Shipbuilder. *w.* $2. New York.
A & N J..Army and Navy Journal. *w.* $6. New York.
A & N R..Army and Navy Register. *w.* $3. Wash'ton.
A R.....Architectural Record. *q.* $1. New York.
A Rev....Architectural Review. *s-q.* $5. Boston.
A S .....Age of Steel. *w.* $3. St. Louis.
A S M E.Am. Soc. of Mec. Eng. *m.* New York.
B B.....Brick Builder. *m.* $2.50. Boston.
B C.....Boston Commonwealth. *w.* $2.50. Boston.
B D.....The Black Diamond. *w.* $3. Chicago.
B G S....Bul. Am. Geog. Soc. *q.* $5. New York.
B I S....Bul. Am. Iron and St. Asso. *w.* $4. Phila.
B J C....Boston Jour. of Commerce. *w.* $3. Boston.
B U W...Bul. of the Univ. of Wisconsin.
B & W...Builder and Woodworker. *m.* $1. N. Y.
C.....Compass. *m.* $1. New York.
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Can A...Canadian Architect. *m.* $2. Toronto.
C & B...Carpentry and Building. *m.* $1. New York.
C E .....Colliery Engineer. *m.* $2. Scranton, Pa.
C E N....Canadian Elec. News. *m.* $1. Toronto.
C Eng....Canadian Engineer. *m.* $1. Montreal.
Ch.....Chautauquan. *m.* $2. Meadville, Pa.
C M.....Century Magazine. *m.* $4. New York.
C M R...Canadian Mining Rev. *m.* $1.50. Ottawa.
Cos.....Cosmopolitan. *m.* $1.50. New York.
D E.....Domestic Engineering. *m.* $2. Chicago.
E A.....Electrical Age. *w.* $3. New York.
E E .....Electrical Engineering. *m.* $1. Chicago.
E E N Y..Electrical Engineer. *w.* $3. New York.
E I.....Electrical Industries. *m.* $1. Chicago.
E M.....Engineering Mechanics. *m.* $2. Phila.
E Mag ...Engineering Magazine. *m.* $3. New York.
E M J....Eng. and Mining Journal. *w.* $5. N.Y.
E N.....Engineering News. *w.* $5. New York.
Eng.....Engineer. *s-m.* $2.50. New York.

E N Y....Electricity. *w.* $2.50. New York.
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E R N Y..Electrical Review. *w.* $3. New York.
E S W P...Proc. Eng. So. of W. Pa. *m.* $7. Pittsburg.
E W.....Electrical World. *w.* $3. New York.
F.....Forum. *m.* $3. New York.
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G R.....Good Roads. *m.* $1. New York.
I A.....Inland Architect. *m.* $5. Chicago.
I Age....Inventive Age. *s-m.* $1. Washington.
Ir Age..Iron Age. *w.* $4.50. New York.
I I G.....Iron Ind. Gazette. *m.* $1.50. Buffalo.
I R W...India Rubber World. *m.* $3. New York.
I S F.....Industry. *m.* $2. San Francisco.
I T R....Iron Trade Review. *w.* $3. Cleveland.
I W .....Indus. World. *w.* $3. Chicago
J A C S..Jour. Am. Chem. So. *m.* $5. Easton.
J A E S..Jour. Assoc. Eng. Soc. *m.* $3. Chicago.
J A N E..Jour. Am. Soc. Naval Engineers. *qr.* $5. Washington.
J F I.....Jour. Franklin Institute. *m* $5. Phila.
J M S I..Jour. Milit. Service In. *b-m.* $4. New York.
J N E W.Jour. N. E Waterw. As. *q.* $2. New London.
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J U S A..Jour. U. S. Artillery. *q.* $2.50. Ft. Monroe.
L E.....Locomotive Engineering. *m.* $2. N. Y.
L. H. P..Light, Heat and Power. *m.* $3. Phila.
L Mag...Lippincott's Magazine. *m.* $3. Phila.
M & B...Manufacturer and Builder. *m.* $1.50. N. Y.
Met W...Metal Worker. *w.* $2. N. Y.
M G.....Manufacturer's Gazette. *w.* $3. Boston.
Mill.....Milling. *m.* $2. Chicago.
Min. R...The Mining Review. *w.* $2. Denver.
M I T....Mining Industry. *w.* $3. Denver.
Mi N....The Monumental News. *m.* $1. Chicago.
M R.....Manufacturer's Record. *w.* $4. Baltimore.
M R C...Marine Review. *w.* $2. Cleveland, O.
M Rec....The Marine Record. *w.* $2. Cleveland.
M S P....Min. and Sci. Press. *w.* $3. San Francisco.
N A R...North American Review. *m.* $5. N. Y.
N B.....National Builder. *m.* $3. Chicago.
N C B...National Car Builder. *m.* $2. New York.
N E M...New Eng. Magazine. *m.* $3. Boston,
N P R...Nat. Popular Review. *m.* $2.50. Chicago.
N S R....The New Science Review. *qr.* $2. N. Y.
N W.....Nowest. Architect. *m.* $3. Minneapolis.
O P D R..Oil, Paint and Drug Reporter. *w.* $6. N. Y.
P.....Paving. *m.* $2. Indianapolis.
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Pr.....Power. *m.* $1. N. Y.
P S M....Popular Science Monthly. *m.* $5. N. Y.
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Sc A S...Scientific Am. Supplement. *w.* $5. N. Y.
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Sea.....Seaboard. *w.* $2. New York.
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S M.....Scientific Machinist. *s-m.* $1.50. Cleveland, O.
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S R J....Street Railway Journal. *m.* $4. New York.
S R R..Street Railway Review. *m.* $2. Chicago.
S V.....Safety Valve. *m.* $1. New York.
T.....Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A I E E.Trans. Am. Ins. Elec. Eng. *m.* $5. N. Y.
T C E....Trans. Am. Soc. Civil Eng. *m.* $10. N. Y.
T Q.....Technology Quarterly. $3. Boston.
Tr A M E.Trans. Am. Ins. of Mining Eng. N. Y.
T W A .Trans. of the Wis. Acad. Madison.
W E.....Western Electrician. *w.* $3. Chicago.

THE FOREIGN PRESS.

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Ry T.. .The Railway Times. £1. 5*s.* London.
S L.....Steamship. *m* Leith, Scotland.
S R.....Sanitary Record. *m.* 10*s.* London.
Tr.....Transport. *w.* £1. 5*s.* London.
W R.....Westminster Review. *m.* $4.50. London.

ARCHITECTURE & BUILDING

The Abbot's Barn, Glastonbury, England.

THAT which is old has special charms for most men; simply on account of its antiquity, and if at the same time it has the added charm of artistic beauty or of historical interest, or both, such a graphic word-picture of it as Mr. A. B. Bibb has drawn of the great Tithe-Barn of Glastonbury Abbey, in the *British Architect*, is delightful reading. This old building dates back to a time prior to the reign of Henry VIII; and it belonged to one of the "earliest Christian establishments in all England,"—one whose name "looms out of the mists that enfold the legendary days of Briton and Saxon."

The title might lead one astray as to the scope of the paper, which includes a brief history of the rise and fall of this great establishment, from a primitive church of wattles and timber built by the Britons, to a monastery church founded by King Ina, a church of stone erected in the eighth century by Dunstan, most renowned of all the abbots; the gradual growth of the abbey to the height of influence, wealth and power; the seizure and confiscation of such of its property as the monks could not hide, and the cruel butchery of Richard Whiting, the last of a hundred abbots of Glastonbury, because he stubbornly refused to reveal where the concealed treasure had been placed. These materials, and scraps of interesting and amusing legends are worked up most entertainingly in an introduction to a description of what are probably the most interesting remains of ancient ecclesiastical architecture in England.

Of these ruins, the old Tithe-Barn, now used as a dairy, is the most conspicuous and best preserved. "It seems a great pity that this remarkable old structure should not have fallen into hands which will lovingly and reverently preserve it as a rare architectural monument of great beauty and interest. It is yet in a surprisingly good state of preservation, and, such is the solidity of its construction, will probably survive many centuries more if cared for. As it is, many slight dilapidations and changes are occurring, and the old barn is suffering irremediable damage."

The general description of the architecture of the Abbey church, St. Joseph's Chapel, the so-called "Abbot's Kitchen" and other buildings belonging to the establishment in its palmy days, forms instructive, as well as entertaining reading. These buildings were examples not only of noble art in their design, but also of a type of buildings erected to endure through many centuries.

The roof construction of the old barn is a singularly interesting study. The author declares it "more elaborate and ornate than many churches afford." It is a remarkable example of the massive, braced and framed carpentry of Gothic England, "put together without nail, the dairy folk proudly inform visitors, sound in every timber and good for a long time to come."

Altogether, considered with reference to its literary excellence, more than its technical value, this is one of the best papers that has recently appeared in architectural publications. It will be read with pleasure and profit, by both professional architects and laymen.

The Ancient University of Paris and Its Colleges.

A GREAT disappointment usually felt by English travelers visiting university towns on the European continent, caused by the want of resemblance in the architectural features of such towns to the famous old university towns of England, is made the opening text of an extremely interesting leading article in *The Builder* under the title given. It is asserted that an Englishman visiting the continental universities "looks in vain for any counterpart of Oxford or Cambridge with their magnificent groups and assemblages of academic buildings. It is true that here and there he

may find some single structure that recalls an Oxford or Cambridge college." Certain exceptional buildings possessing such resemblance are cited; but it is asserted that they are solitary examples, and that, "to an Englishman's mind one college can no more convey the notion of a university than one swallow can make a summer."

"He thinks of Christchurch, Merton, Magdalen, and some twenty others, or of Trinity, St. John's, and all their companions, forming grand architectural groups crowned by spires, domes and towers. He pictures to himself streets flanked by wide-fronted buildings; and gateways leading into noble courtyards, with lofty buttressed and pinnacled chapels; dining-halls with pitched roofs and louvres, and exquisite gardens and groves running down to the banks of a clear river."

The various universities of European towns are then passed in review. Paris comes in for a severe criticism upon the decay of architectural beauty in her university buildings.

"The want of grandeur and dignity in these buildings of Paris is all the more strongly accentuated from the fact that all the old buildings in the neighborhood are characteristic, and many of them extremely beautiful. The splendid old church of St. Étienne du Mont, the stately Romanesque St. German des Prés, the interesting Gothic churches of St. Severin and St. Médard, the lovely Flamboyant Hôtel de Cluny, the stately Renaissance St. Sulpice, the Luxembourg, and notwithstanding a certain amount of ugliness, even Soufflot's portly bulk of the Pantheon are all striking examples, and possess those merits which are remarkable by their absence in the university buildings. How the latter must have deteriorated from what they were in mediæval times; and how a single century has sufficed to convert what was once an Oxford or a Cambridge into a dull, gloomy 'education factory.' It is next to impossible to realize the fact that, on this same spot, formerly stood a series of academical buildings which were unsurpassed anywhere in Europe."

An interesting list and brief descriptions of these old buildings follows, and the author finds it difficult to account "for the constant destruction of ancient monuments which is going on all over France, and more especially in Paris." Some will see in this a decay of taste perhaps traceable to a change in the character of the French people since the republic has supplanted monarchy; but however this may be, the fact remains that reverence for the past is not evinced by conservation of architectural features whose beauty and grandeur ought to be carefully preserved as the inheritance of future generations.

The Origin of Gothic Architecture.

A RATHER transcendental view of this subject is taken in an article written by Mr. C. Bryant Shaefer in *The Inland Architect*. He classifies architecture into three principal orders, to wit, "Mohammedan, the feminine; Grecian, the masculine; and Gothic the expression of both. The Roman, Romanesque, Byzantine, and many other styles are variations on the principal themes." The aim of the article appears to be to sustain the thesis that Gothic architecture was the natural expression of the new growth in "higher experiences which the world entered upon nineteen centuries ago." Good samples of the flavor of this article are presented in the following propositions:

"The first digramatic illustrations made by man proceed at once upon diametrical lines of development. One of these is literal representation and the other illiteral. The former is the systematic progress that develops into alphabets. The latter is the cultivation and the expression of faith. It is ornamental as opposed to the useful.

"Gothic art and all art, it must be remembered, is the opposite of religion, as commonly understood. The modern symphonic-drama is its culmination, and bears the same relation to this new sphere of exercise as the Pantheon, created by the Greeks, did to their accomplishment. The old philosophical process, best represented then by Socrates, accompanies it as the natural mental condition of the present."

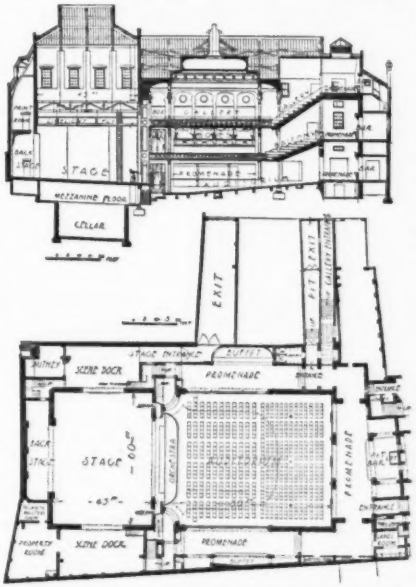
There is an esoteric flavor to this discussion that a certain class of readers will relish.

Theaters—V. The Paragon Theater.

AN important series of papers on this subject from the pen of Mr. E. A. E. Woodrow, is continued in this, the fifth number of the series in *The American*

Architect, wherein is given an illustrated description of the Paragon Theater, situated in the Mile End Road, Whitechapel, London. The characteristic feature of the paper is that it describes minutely a place of amusement designed to meet the requirements for the poorer classes of population in a very large city; and from it may be obtained hints of value to any architect who is liable to be commissioned with the execution of similar work.

The theater had its origin in an East End music hall, which has been transformed by the architect's skill into a building completely adapted to its present use and the character of its patrons who, the author states, are in many respects unlike any other part of the population of London. "The character, dress and even accent of the East Enders are characteristic and unique; the coster and his girl have been the subject of so many sketches and illustrations that, doubtless, their peculiarities are familiar even to the readers of this professional journal."



LONGITUDINAL SECTION AND PLAN OF PARAGON THEATER, LONDON.

To accommodate the requirements of this peculiar class of patrons "a large and open floor for occupants of the area, or pit and stalls seats" has been supplied, and these divisions of the audience are surrounded "by raised promenades on three sides, the fourth side being occupied by a stage of such a size as to be capable of mounting any play or ballet." This arrangement is said to have proved singularly well adapted to the wants of those who patronize the theater. Other very interesting details related to the special requirements of this case, are given; and as a study of adaptation to such requirements this number of the series appears to fully warrant the view that the theater described is an example of rare value in this particular field of architectural design. A plan and vertical section of this theater are given in the accompanying diagrams.

How to Study Design.

In a paper recently read before the Architectural Association, London, by Mr. A. Berbsford Pite, discussing the study of architectural design with reference to the future of architecture, is made an exceedingly strong plea for originality finding its spring and impetus in the wants, characteristic features, and tendencies of the present age, rather than in the spirit of past ages. It is much easier, as a rule, to ask than to answer questions beginning with the small but immensely embracing interrogative, "Why?" So when the author, at the very outset, hurls at us a number of ponderous queries such as are quoted below, and then proceeds to answer them, something quite original and interesting may be expected in the replies. In this expectation the reader will in no wise be disappointed. Among many questions propounded and discussed with ability are the following:

"Is it possible to design in harmony with the spirit we live in, or to distinguish between the archæological and architectural beauty of ancient buildings? Why cannot we design buildings as an engineer designs an unsophisticated iron bridge without the result being hideously ugly?

"Will not the terrible buildings of the Victorian Gothic Era with which our land is bespattered have in the eyes of succeeding generations the same beauty (is it architectural or archæological) that the crude classic productions of the Jacobean and Queen Anne periods have in our own?"

This last question is freighted with an idea that pervades the entire discussion, to wit, that much of the beauty attributed to ancient architecture is archæological rather than architectural, and that fondness for what is old cannot rightly be made a standard for beauty or fitness in the present stage of human progress.

"Imagine yourself, if you can, sitting down to design a church or a house in the country with the stipulation that you were not to revive any ancient style in your building. Does not the thought seem both absurd and painful? If so take for your subjects either a factory, say for boot blacking or fancy soap, or a railway station block, in which it ought to be both absurd and painful to employ any ancient style, and see how you will be able to get along without the seemingly indispensable history. And yet, if history teaches us anything as to the sources of life and motive in design, it shows that the Greeks had little or no history of architecture to draw upon and revive; and that the Goths, who probably knew little or nothing as to ancient art, deliberately set aside the productions of their ancestors, even as types, and thought and acted for themselves alone. Can any one say the results do not justify their methods of study? Shall we be forced to accept as a conclusion that the less we have of the study of architectural history, as at present conducted, the better?"

The author disputes the propositions that "ancient styles are the languages of the art of architecture, that their forms and details are its words, and that our fine imaginings without such words and diction are vain and incapable of realization"; and he asserts with equal positiveness that, while it has its uses, the study of ancient styles, and of other things the mastery of which will qualify a student to pass the art section of a qualifying examination, is "in no sense a qualification for the practice of modern architectural design."

In the view of the author a reconsideration of methods that will bring the profession of architecture face to face with present problems, rather than the championship of a "past style and dead art,"—a method that will supply equipment for advancing the art in the spirit of the age, is what is needed at the present time.

It is suggested to eminent examiners, among other things, that such a question as "Why is the Parthenon beautiful?" is a much more vital one than in what technical terminology pedants would describe it, or how many columns compose the portico, and other like trivialities; and he adds that "until we seek to study the reason why things are beautiful we shall never know how to design."

Various estimates will be put by architects on the value of the opinions expressed in this rather radical essay; but all will agree that the paper is widely suggestive, and that the points made in it are such as may be profitably considered by all who desire architecture that will not only be characteristic of the present age, but which shall be beautiful as well.

Architects' Fees.

A BRIGHT young man from the country having registered as a student with a city physician was set at work by the latter to making out bills of those who were in arrears on the physician's books. After several days of this distasteful labor the embryo doctor ventured, in a timid way, to ask his preceptor when the study of medicine would be likely to commence. Thereupon the old doctor thundered at him:

"You have already begun, and are making good progress. The most important thing in medical practice is to know how to charge for services."

The theme of an editorial article in the *British Architect* relates to a similar important element in the practice of the profession of architecture. The position is taken that the system of percentages on outlays is, in a sense, a survival of the fittest, and, as such, is likely to be maintained even in the face of what the author is pleased to style, "much severe criticism." Starting with this proposition, the article proceeds to discuss the merits of the sys-

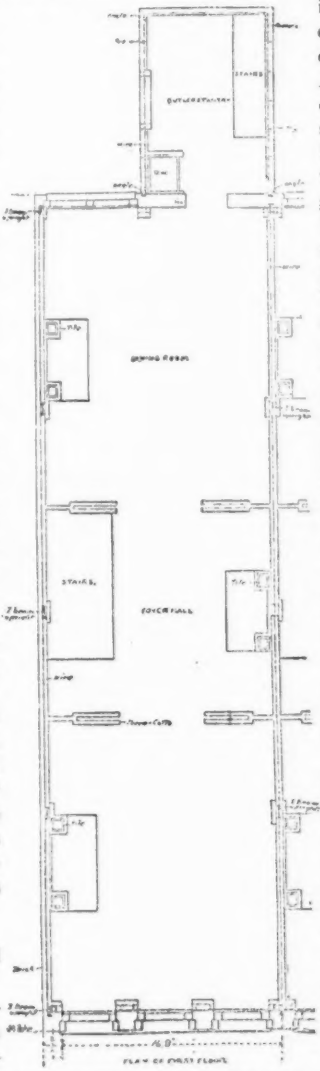
tem, as contrasted with methods of compensation in other professions. The author claims that, while the system is liable to abuse, the main body of architects are "quite as upright in their desire to serve their clients to the best of their ability as are members of the legal profession, whether solicitors or barristers."

The impression that architects, worthy to be so called, are overpaid for their services, is, in view of the laborious and exacting character of their work, emphatically denied.

The cutting of percentages to figures below the standard, is discussed, and regarded as a mistake, even when practiced by a beginner desirous to gain a business connection. Another mistake distinctly pointed out is the commencement of work without some memoranda regarding the fees which will prevent disputes. A pleasant and instructive account of a futile attempt to reduce an honest bill for services rendered by a young practitioner who resisted it with firmness and success very appropriately illustrates this point.

Iron Construction Applied to City Dwellings.

THE tendency to the increased use of iron in the construction of buildings makes any real contribution to knowledge of the subject of importance and interest. It has been popularly supposed that, as compared with ordinary materials for the construction of the smaller class of buildings such, for instance, as city residences, iron would prove so much more costly as to render its use impracticable. This, however, is shown to be erroneous in *Architecture and Building* by a practical example of such construction, described with illustrations of details in the article whose title is given above. Mr. Manly M. Cutter, a New York architect, prepared plans for three ordinary city houses to be erected chiefly of iron, brick and terra cotta, in accordance with the building laws of New York city; and to cost, as nearly as possible, the same as buildings of the ordinary kind. The three buildings are designed to be erected on two adjoining city lots, each twenty-five feet in width. The complete specification for the buildings forms a part of the article.



IRON CONSTRUCTION IN CITY RESIDENCES.

Estimates for the construction having been obtained for this specification, and also for the ordinary construction of brick with timber beams, etc., it was found that the difference in cost of the iron construction over that with usual materials is only $211.66 for each house a result which justifies the conclusion that the projected innovation sets the pace for an improved and safer method of city residence building, reached at a merely nominal increase of cost. A plan of the first floor is herewith reproduced; and a portion of the specification that indicates in how far iron enters into the construction, is also given in the following ab-

stract. Below the underside of the basement the structure is wholly of brick or stone.

OUTSIDE WALLS.—On top of walls at the under side of basement floor place cast iron plates for steel uprights of main building and extension. These uprights will be in the main building of wrought steel I beams, carried up to the under side of roof beams in manner shown. Between these uprights, for the support of each floor and roofs, place a wrought steel I beam girder. Between the uprights and girders stretch a woven wire screen fastened to uprights and girders in manner shown. For extension erect the uprights of tee and angle irons. For the support of floors and roof fasten to the uprights an angle iron as shown. Between the uprights and angle iron stretch a woven wire screen fastened to the uprights and angle irons.

FLOORS AND ROOFS.—On top of the cellar walls and at girders of main building and extension set the steel floor beams for each floor and roof. From the top of beams suspend and fasten a woven wire screen; fill in between beams and on top of wire screen with concrete 3 inches above top of beams and 1 inch below center of wire screen, or as shown. On the under side of beams stretch the metal lathing and cover the same with plaster. On top of concrete insert wooden furring strips for the rough floor.

BRICKWORK.—For the independent walls of main building and extension build up on the outside of wire screen from the top of cellar wall to within three inches of top of roof beams, 4 inches of brick, laid in cement. Above this will be built the coping walls. All to be thoroughly anchored. Top out the chimneys as shown above the roof.

The front and rear walls of main building to be built in the usual manner of stone and brick.

ROOFS.—To be boarded and tinned in the usual manner; bluestone coping for coping walls and chimney caps. Galvanized iron gutters, conductors and cornices.

Caisson Foundation Piers.

THE *Scientific American* has printed an article dealing with the increasingly important subject of foundations for tall buildings. The particular building whose caisson foundations are described, is notable as being one of the tallest yet erected in New York city. Engravings showing the building as it will appear when completed, the work in progress, and details of its construction illustrate the description, which is non-technical and written in a popular style. The foundations of the piers are carried down to bed rock by means of caissons employed in a manner entirely analogous to that adopted for the towers of the celebrated New York and Brooklyn Suspension Bridge and other noted works, in which no excavation is made except from directly under the caissons, and the material so excavated is taken out through air-locks. A particularly interesting feature of the work, in the special instance cited, is the constant maintaining of so high a pressure in the caissons as practically to squeeze the water from the excavated material, which is thus taken out comparatively dry, and the foundations of adjacent buildings are not endangered.

INDEX TO LEADING ARTICLES.

*24206. Recent Architecture in Philadelphia. Ill. W. P. Laird (E Mag–Oct.) 3000 w.

24229. Basis of a Successful Architectural Practice in the Twentieth Century. W. Howard Seth-Smith, with Discussion (A & B–Aug. 11.) 4800 w.

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†24376. The Optical Recognition and Economic Importance of the Common Minerals Found in Building Stones. Lea Mc I. Luquer (S M Q–July.) 17000 w.

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*24449. The Future of Architecture. P. Morley Horder (B A–Aug. 10.) 1700 w.

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*24474. How to Study Design. A. Berbsford Pite (Can A–Aug.) 5000 w.

*24475. Foreign Ornamental Plastering (Can A–Aug.) 2000 w.

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24510. Caisson Foundation Piers of the

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American Surety Company's Building in New York City. Ill. (Sc A-Aug. 25.) 950 w.

24512. Caisson Work (Sc A-Aug. 25.) 700 w.

24547. The Battle with Fire. (Abstract) Professor Norton (A & B-Aug. 25.) 1000 w.

24548. Iron Construction as Applied to City Dwellings. Ill. (A & B-Aug. 25.) 700 w.

*24580. The Ancient University of Paris and its Colleges. Ill. (B-Aug. 18.) 4000 w.

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*24937. Is a New School of Architecture Possible? (B A-Aug. 31.) 1500 w.

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24786. Specification Writing. T. Roney Williamson (A A-Began Sept. 1—2 parts to date—15 cts. each).

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal Engineering."

Improving the Erie Canal.

THERE are many who regard the deepening of the Erie Canal, connecting the city of Buffalo with the head of navigation on the Hudson river at Albany and Troy, a work that should be undertaken by the State of New York without any delay. The project is under consideration by the Constitutional Convention now sitting at Albany, and the Marine Record gives an abstract of an estimate transmitted to this body by State Engineer Adams. The proposal is to deepen the canals of the state to nine feet. State Engineer Adams says:

To raise the water surface of these canals two feet would probably cost three times the amount of the estimate as shown, and to lower the bottom two feet would unquestionably increase the estimate ten fold as it would necessitate taking down and rebuilding nearly every structure on these canals. It would hardly seem that either of these latter plans would be judicious in view of their great cost and the comparatively small benefits to be derived therefrom, as it would in either case still be necessary to transfer all cargoes from lake ports at Buffalo the same as under existing conditions.

The estimates here referred to are understood to be those hitherto made for raising the banks one foot and deepening the bottom one foot, thus gaining two feet upon the present depth. The estimates of cost for the several canals in the state to secure the requisite depth are as follows:

Erie Canal.....	$5,310,000.00
Oswego Canal.....	1,208,000.00
Champlain Canal.....	4,300,000.00
Black River Canal.....	8,880,000.00
Cayuga and Seneca Canals.....	260,000.00
Oneida River Canal.....	335,000.00
Total.....	$20,293,000.00

The above estimates contemplate the most permanent work possible, to the end that the cost of repairs shall be reduced to the minimum.

The report admits that boats carrying the same load as now could, with this improvement, save nineteen hours between Buffalo and West Troy; and that single boats could carry twenty-five tons more load than at present and yet save six hours in transit, with the same draft on horses as is now required.

With reference to propellers it is also admitted that greater power would be obtained from their deeper immersion.

The report goes on to say that "no lengthening of locks has been done on any of the canals except on the Erie and Oswego canals," and that "the probable cost of lengthening all locks on the Erie and Oswego, not already uniformly lengthened, is easily obtainable."

Of the thirty-three locks on the Erie Canal out of the total of seventy-two which have not already been enlarged the cost of enlargement is estimated at an average of $35,000 for each lock. On the Oswego Canal, out of eighteen locks, eleven have been enlarged, and the estimate for enlarging the remaining forty-three locks is $2,755,000.

State Engineer Adams expresses the opinion that any plans for canal improvement more radical than the one first above mentioned and "less radical than for a ship of twenty feet draft would not produce results commensurate with their cost." He promises to make a special report on the cost of such a ship canal in the near future.

A Necessary Drainage Project for Manitoba.

THE great savannahs lying between Lakes Manitoba and Winnipeg constitute a vast morass whose effects upon climate are noted by Mr. J. Bawden in an attempt to indicate advantages that would follow a drainage system proposed and advocated by him in the article under review printed by the *Canadian Engineer*. He asks:

"Can there be any doubt that over this vast wet blanket of country the great evaporation in progress in July and early August converts the region into a refrigerator whence icy currents move southward over the ripening wheat fields?" The position taken in the article is that "arterial drainage" is the only means whereby this cooling and frost-breeding effect can be lessened.

It has been proposed to utilize for power purposes the rapids of the Assiniboine river, on the west end of Red river, north of Winnipeg. The writer of this paper takes the ground that the erection of a dam for such a purpose would be likely to increase the damage from frost by reason of the subterranean back water it would cause.

Also it has been proposed to build a lock to admit the passage of vessels from Lake Winnipeg to the city of Winnipeg. This scheme, the writer maintains, has been advocated, without proper knowledge of the situation. On this point he says:

The latter project has not been discussed, so far as the writer is aware, with a full comprehension of the facts. The most striking phenomenon confronts us at the outset of enquiry. The volume of water flowing in the Assiniboine river is at several points in its course very much larger than is discharged into Red river at Winnipeg.

Prof. H. Y. Hind, in his report of the Assiniboine and Saskatchewan Exploring expedition, 1859, gives the following figures:

VOLUME OF WATER IN THE ASSINIBOINE.

	Cubic feet per hour.	Distance from Fort Garry.
Lane's Post.....	5,702,400	22 miles.
Mouth of Little Souris..	12,899,840	140 "
Opposite Mt. Ellice....	9,979,200	289 "

The existence of one or more subterranean discharges into Lake Manitoba is alleged. An effort to drain a tract in the vicinity of Long Lake near Poplar Station, by cutting an outlet into the Assiniboine has, in accordance with traditions of a contrary current there, proved abortive. Prof. Hind's report credits Rat river with carrying the freshets from the Assiniboine into Lake Manitoba. At page 71, he states that "down its valley the water of that river (the Assiniboine) during freshets, flows into Lake Manitoba, and by making a very shallow cut a permanent communication in time of high water could always be maintained."

Lake Manitoba being about 40 feet higher than Lake Winnipeg, in a distance of 40 miles, Mr. Bawden is of opinion that "a canal water-way can be constructed between the larger lakes, the motion of which would be of incalculable benefit to the province." It must be admitted that the arguments employed to sustain this proposition are forcible, in view of the peculiarities of the water system of the region which are pointed out. In conclusion Mr. Bawden says:

The reclamation of some four thousand square miles of excellent land, now too wet for cultivation, well merits the immediate attention of Mr. Greenway's government. The future of silent leagues of prairie has been given over to the landgrabber, and the homeseeker is invited to move on from Manitoba to the cheaper land in the territories. It will be a fine stroke of enterprise to divert a part of the waters of the Assiniboine by canal into Lake Manitoba, and thence by a canal from this lake into Lake Winnipeg, to drain an immense area of fertile soil and mitigate the rigors of the climate. The enterprise will be all the more successful if the land reclaimed shall be thrown open to free settlement. Manitoba wants men rather than capital for the development of her vast agricultural wealth. Capital has been sufficiently invited to sit down in the prairie province, with the result that it holds millions of unproductive acres, and waits to prey upon the vitals of the laborer who alone can make the possession productive.

The Goulburn River Weir, Victoria.

IN many parts of the world a serious difficulty to be contended with lies in severe and protracted droughts. This difficulty has been so formidable in Australia that in 1884 a Royal Commission was appointed to investigate the subject, and in their report the commissioners emphasized the fact that "on water conservation mainly depends the prosperity and development of the whole extent of the central and western divisions of the colony." This was followed by a report from Mr. H. G. G. McKinney, the government engineer, detailing results of the investigations and advising a scheme for storing and distributing the water of the upper Murray

river at a cost, including distributing works, of £1,412,250. The delivery contemplated in this scheme was the enormous volume of 155,520,000 cubic feet per day; or a mean rate of delivery of 1800 cubic feet per second. It was also estimated that this amount of water would irrigate 270,000 acres; that it would yield a gross revenue of £177,500 a year, and a net profit, after allowing for both interest and repairs, of £100,000 annually.

Hitherto irrigation works in Australia have been mainly private enterprises, and this seems to be about the first example of works constructed for the purpose by the government. The scheme, as originally proposed by Mr. McKinney, has been extended to provide a supply for the irrigation of 775,000 acres. Enough has now been said to indicate the importance of the work.

The means for conserving the water of the Goulburn river, a tributary of the Murray river, is a weir 695 feet long, which, together with the channel regulators employed, 230 feet long, make a total length of 925 feet. The weir is composed of large blocks of concrete "banded together, bedded and jointed with cement mortar," says *The Engineer*, this being preferred to monolithic construction on account of the cracks that inevitably develop in large masses of monolithic concrete.

The waterway in the upper portion of the weir is occupied by twenty-one floodgates, each having a clear opening of 20 feet and a vertical depth of 10 feet. These, when required for the escape of flood-water, can be lowered into recesses in the body of the structure, and can be adjusted so as to maintain the water level at the off-take at the normal level. The frames of the gates are rolled T-iron beams, having 7-inch section in the tables with ¾ inch web. They are 13 inches deep at the center, curved to 8½ inches at the ends. The frames are filled in with cast-iron plates; each gate weighs seven tons. They are worked by screw gearing, carried on the gangway of the bridging, and actuated by three 30½ inches Leffel turbines. The turbines can be worked together or separately, and any or all of them can be brought into gear with any of the gates. The head available for working the turbines varies from 3 feet to 13 feet, giving 3 horse-power, with 78 revolutions per minute, to 27 horse-power, with 163 revolutions. Hand gearing to each gate is also provided in case of accident. For the purpose of working the gates in case of sudden floods coming during the night, an electric plant of five arc lamps, each of 2000 candle power, has been provided. The dynamos are worked by a 23-inch turbine.

From the above quotation it will be seen that this work, begun in 1867, and now substantially brought to completion, is entirely up to date in methods, means, and appliances. The article is based on a report prepared by Mr. Stuart Murray, Chief Engineer of Water Supply, and published at the cost of the Victorian government. This report was prepared with the expectation that it will prove serviceable to engineers and in order "that the details of a work so important and costly may be subjected to the fullest and widest criticism. A table of the cost of different parts of the work, as excavation, masonry, etc., is embodied in the report."

Diagram for Calculating Length of Covers for Plate Girders.

A SHORT paper printed in *Engineering News* contains a valuable diagram. The text explains that the diagram was prepared for use in the works of the Dominion Bridge Company, and tells how to use it. The diagram, herewith reproduced, is based upon the principle that "the bending moment at any point of a uniformly loaded girder is measured by the ordinate through that point of a parabola whose axis is the vertical through the center of the girder, and whose base is the horizontal line between the points of support. The diagram therefore consists of a series of such parabolas from which the lengths of cover plates can be easily found." The facility with which this diagram can be used must commend it to all who examine it.

Any boy who knows the fundamental rules of arithmetic could be taught in a few moments how to use it accurately and readily. The diagram is here too much reduced in size to be convenient for use, but its reproduction will serve to illustrate its value.

"*Example.*—Suppose the section at the center is 38 square inches and the cover plate is 16 inches × ⅛ inch = 8 square inches. The difference is 38 — 8 = 30 square inches. On the diagram the horizontal line through 30 intersects the parabola through 38 at 0.46 from the end. If, then, the span of the girder is 60 feet, the length of cover plate will be 60 × 0.46 + 2 feet for rivets = 29 feet."

Methods of Testing Hydraulic Materials.

CONSIDERING the fact that hydraulic mortars and cements have so long been known and used, and their qualities have been so much studied, it seems at first thought surprising that there should yet be anything relating to their practical employment remaining to be found out, or that anything new or important could be said or written upon the subject of testing these materials. The fact is, notwithstanding, that the phenomena which takes place during what is called "setting" are yet subjects of speculation to some extent; and that researches are still directed to clearing up some of the peculiarities in the behavior of these substances. H. le Chatelier has contributed a paper to *Annales des Mines*, discussing methods of testing which indicates some of the tricks and manners of hydraulic materials. An abstract of this paper is reprinted in the *Engineering Record*.

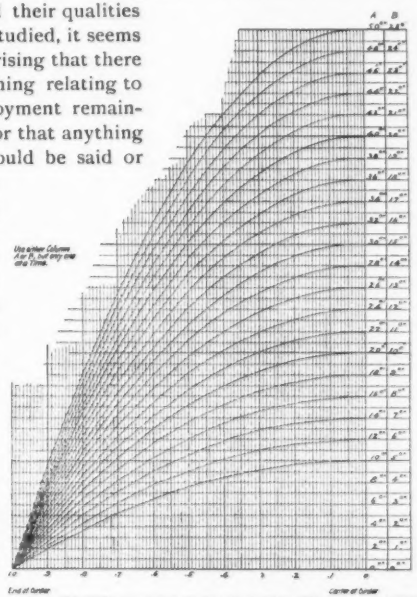


DIAGRAM FOR DETERMINING THE LENGTH OF COVER PLATES FOR PLATE GIRDERS.
T. Kennard Thomson, Chief Engineer Dominion Bridge Co.

While a chemical test with most substances used in industry, indicates their value quite conclusively, such an analysis cannot prove that a hydraulic cement is of good quality, though "it might demonstrate that a certain product is undoubtedly bad. For instance, a deficiency of silica or alumina will show that the cement is not sufficiently hydraulic. The chief utility of the chemical analysis of cements is, however, to indicate the presence of injurious substances such as sulphate of lime, or sulphides. The paper is full of valuable suggestions. The author says "the relation of crushing to the tensile strength, is not a fixed quantity, but the former is generally about ten times that of the latter. With increased age the crushing strength becomes greater in proportion to the tensile." In crushing tests erroneous results may be indicated through failing to get parallelism between the surfaces subjected to pressure. Owing to sources of error in cushing machines, the author concludes that it would be premature to substitute crushing for tensile tests, although he has himself constructed an apparatus for such tests, in which some sources of error previously existing are removed.

This most exhaustive of recent essays on testing cements finally brings us to the conclusion that, "neither for resistance to sea-water nor for adhesion is the present state of knowledge sufficient to institute satisfactory tests"; yet a careful perusal of the paper cannot fail to lead to more refined methods than are often practised, and thus to general advance of knowledge upon a confessedly difficult subject.

Cleaning Water Mains.

CONCERNING some devices for effecting this important kind of work without which the capacity of water mains may in many situations become seriously impaired, Mr.

Herbert Henderson, Assoc. M. Inst. C. E., writes interestingly in an illustrated article printed in *The Railway Review*. The cuts illustrating the machines described have been kindly loaned to us by the publisher and are herewith reproduced.

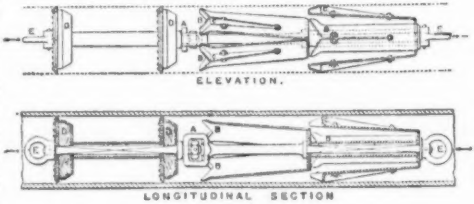


FIG. 1—WATER MAIN CLEANER.

Figure 1 is the longitudinal scraper designed by Appold, and subsequently modified by Kennedy. "It consists of two distinct portions connected by a swivel joint *A*; the front, carrying the steel scrapers, and the rear the wrought iron or steel propelling pistons. Leather disks intersected by radial cuts and stiffened at the back by lead plates, are placed behind each piston. The springs *B* with steel scraping edges *C*, are arranged in two sets of four each, the set behind breaking joint with that in front. For larger sizes the form shown in Figure 2 is used.

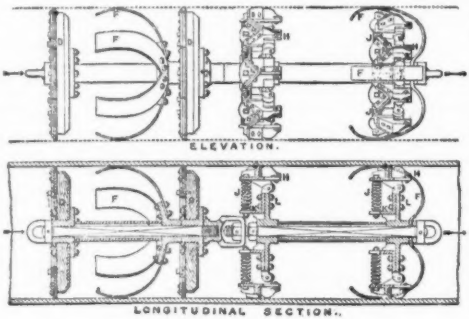


FIG. 2—WATER MAIN CLEANER.

The weight is carried by the curved steel springs *F*, one set at each end of the machine. The construction of the pistons, leather disks, and the connection between the front and rear portions, are similar to that of the smaller machine. The scraping knives are fixed to rocking brackets *H* pivoted to disks *L* attached to the center rod, and are forced against the interior surface of the pipe by spiral springs *J*, which are fixed at one end of the brackets *K* carried by the same disks *L*.

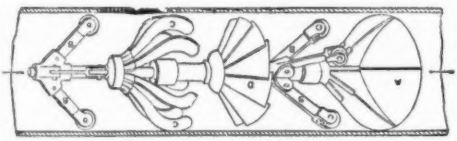


FIG. 3—AMERICAN GO-DEVIL.

These machines are placed in the mains through hatch boxes or access pipes, and they are forced through the mains by water pressure exerted against their pistons. A detailed description of the method of using is given in the article quoted. Figure 3 illustrates a device used for cleaning out oil pipes. The author does not know whether or not the latter has also been used for cleaning water mains.

THE indexed article entitled "The Hydraulic Dredge on the Chicago Drainage Canal," with the pictorial inset completely illustrating the machine and its details, printed in *Engineering News* is an interesting description of a particular example of a very important class of machinery employed in river and harbor work. "The feature of principal interest is the cutter, a hollow steel cylinder 5 feet in diameter and 4 feet long, armed with steel knives. These knives are so inclined as to throw the material inward toward the opening of the suction pipe as the cutter advances. The suction pipe is 20 inches in diameter and both it and the shaft which operates it are carried by the '*ladder*' which takes the place of the dipper boom in an ordinary dredge, and has a length of 39 feet." The suction pipe is connected at the top of the ladder to the cast-iron pipe on the barge, by a vertical telescope joint. The effectiveness of the machine is shown by the statement that, in a run of 230½ hours, the excavation averaged 446 cubic yards per hour. The machine was designed by Mr. Lindon W. Bates, President of the American Hydraulic Dredging Co.

The Cape Hatteras Lighthouse.

ACCORDING to Mr. W. M. Patton in *The Engineering Record* (August 11), a lighthouse "must and will be constructed on Diamond Shoals, off Cape Hatteras, on the Atlantic coast." He also says that only one determined effort has been made to erect this structure, which, as is well known, proved a disastrous failure. The method of letting the contract for so important and difficult a work is criticised adversely. It appears that the lowest bidder was awarded the contract in accordance with the statute, out of three who offered to erect the structure, and there does not seem very solid ground for this criticism. That there is sufficient skill, ability and experience among American engineers to erect a structure "even on that stormy coast," is the belief of Mr. Patton, and he thinks few engineers in the country would be prepared to admit that there is not sufficient engineering knowledge and skill to accomplish this feat, notwithstanding that so able and experienced a firm as Messrs. Anderson and Barr have expressed, in the same journal, the view that it was next to impossible to construct a lighthouse on the plans approved by the lighthouse board. Mr. J. F. Anderson, writing on the part of the above named firm says, that although dozens of plans, some quite complicated, have been shown him, and although their authors had confidence that their plans would be successful, "when the conditions against which they would have to contend were shown them they weakened; at least none has offered to back his project substantially." Mr. Patton claims to have designed a form of "temporary protection by which the force of the waves will be greatly reduced, scour will be prevented, comparatively quiet water produced over a certain area, the work and workmen protected from heavy seas, and the work proceeded with without danger." He asserts that he has submitted this design to several engineers and builders of experience, also to two accomplished seamen of skill and ability, as well as experience, and that they have endorsed it unqualifiedly. In Mr. Anderson's letter replying to Mr. Patton he expresses skepticism as to the advice and endorsement of sailors on such a work as this. He claims that the records at the signal office at Hatteras show that there had been no such storm in the month of July during eight years as the one his firm encountered in the effort to construct the lighthouse above referred to. And he also adds that a captain of a vessel which lay in Pamlico Sound, at Ocracoke, told him "it blowed so hard that he was unable to walk from the stern of his vessel to the bow without pulling himself along the rail." Much may be learned from the letter of Mr. Patton and Mr. Anderson's reply thereto relative to the great difficulties which must attend any attempt to erect a lighthouse on this site.

THE Board of Experts' report on the Hudson River Bridge at New York city is the most important engineering document that has recently been printed. *Engineering News* publishes it substantially as it came from the Board. The report pronounces either a cantilever or suspension bridge practicable from an engineering point of view, but a cantilever of 3100 feet clear span would be impracticable financially on account of its great cost, though it could be made perfectly safe. A suspension bridge could also be made a safe structure; but its cost would be about one-third more than that of a cantilever bridge of 2000 feet span. The experts decline to state that the greater cost of the suspension bridge should put it out of consideration as a financial scheme, in view of other advantages it possesses, and also in view of contingencies that will have to be met in constructing the deep-river foundation of the proposed cantilever bridge.

VARIOUS kinds of roads, their comparative value for service and their construction having been treated in two previous articles of this series, the writer, M. W. H. Breithaupt, discusses in this concluding paper in *Canadian Engineering* the subjects of cost of roadmaking and keeping roads in good repair. Statements of cost made from cost records in various locali-

ties are interesting. Cost of gravel roads is given as from 13 cents to 50 cents per square yard, and even more in some localities and under peculiar conditions. Broken stone roads will cost $2640 and upwards per mile of 16 feet width. To get best service out of roads a system of "continuous maintenance" should be adopted, that is, a system that will promptly remedy all defects as they are developed by use. The various means and appliances for doing this work are discussed together with methods of using them, including road scrapers, rollers and hand rammers, the latter being very useful in levelling down small inequalities.

INDEX TO LEADING ARTICLES.

Bridges.

24382.—$1.50. Failure of a Masonry Pier and a Rock Foundation. Ill. William Barclay Parsons, with Discussion (T C E-June.) 2200 w.

24383.—$1.50. The Reconstruction of a Portion of the Substructure of the Johnsonville Bridge. Ill. Walter H. Gahagan, with Discussion (T C E-June.) 7000 w.

24525. Diagram for Calculating Length of Cover Plates for Plate Girders. T. Kennard Thomson (E N-Aug. 23.) 200 w.

24539. The Winona Bridge. Ill. (E R-Aug. 25.) 1200 w.

24873. Experts' Report upon the Proposed Hudson River Bridge at New York (E N-Sept. 6.) 8000 w.

Canals, Rivers and Harbors.

24215. Can the Nicaragua Canal Company Transfer its Property to Foreigners? (M R-Aug. 10.) 1000 w.

24230. Improving the Erie Canal System (M Rec-Aug. 9.) 1200 w.

†24544. Inundation Canals.—Excessive Silting Merely a Popular Fallacy. E. A. S. (I E-July 21.) 800 w.

24818. Progress of the Work on the Drainage Canal. U. W. Weston (R R-Sept. 1.) 2000 w.

24874. The Bates Hydraulic Dredge on the Chicago Drainage Canal. Ill. (E N-Sept. 6.) 1100 w.

*24880. The Chicago Inter-Land Canal (I S F-Sept.) 1500 w.

†24897. Canal du Havre a Taucaville. A. W. S. (I E-Aug. 4.) 600 w.

*24914. The Manchester Ship Canal.—Half-Yearly Meeting (E-Aug. 31.) 1800 w.

*24939. The Harbor and Dock Improvements at Portsmouth (Tr-Aug. 31.) 1300 w.

Hydraulics.

*24253. Nile Reservoirs and Philæ. Ill. (E-Aug. 3.) 1100 w.

*24262. The Goulburn River Weir, Victoria. Ill. (Eng L-Aug. 3.) 1400 w.

24276. A Necessary Drainage Project for Manitoba. J. Bowden (C Eng-Aug.) 800 w.

†24378. Project for Utilizing Bassasseachic Falls. Ill. Edward D. Self (S M Q-July.) 3000 w.

24386. A Mathematical Investigation of Stand-Pipe Failures. E. C. Murphy (E N-Aug. 16.) 500 w.

24540. Methods of Testing Hydraulic Materials. (Abstract.) H. le Chatelier (E R-Aug. 25.) 2400 w.

Miscellany.

24243. Colorado Roads and Scenery. Ill. Edward B. Light (G R-Aug.) 2800 w.

24288. The Cape Hatteras Light House.—Communications from W. M. Patton and John F. Anderson (E R-Aug. 11.) 4500 w.

24380.—$1.50. Address of President William P. Craighill at Niagara (T C E-June.) 5400 w.

24492. Cleaning Water Mains. Ill. Herbert Henderson (R R-Aug. 18.) 700 w.

24503.—75 cts. A Proposed Formula for White Pine Posts. James H. Stanwood (T Q-April.) 200 w.

24559. Roads in the Yellowstone National Park. Ill. Hiram M. Chittenden (R M-Aug.) 5000 w.

*24732. Good Mortars; Their Cost, Strength and Durability. How to Mix Properly. R. N. Buell (B B-Aug.) 1000 w.

24792. The History and Construction of our Highways, and Who Should Build Them. N. G. Spalding (G R-Sept.) 1700 w.

24798. The Roads of Fairmount Park, Philadelphia. Ill. (E R-Sept. 1.) 1500 w.

*24921. The Alignment of Tunnels. Editorial (Eng L-Aug. 31.) 2000 w.

Serials.

21592. The Harlem River Speedway (E R-Began April 28—7 parts to date—15 cts. each).

22793. Road Engineering. W. H. Breithaupt (C Eng-Began June—Ended Aug.—3 parts—15 cts. each).

23669. Centrifugal Pumps. Ill. John Richards (I S F-Began July—3 parts to date—30 cts. each).

24032. Road Making in the South. W. E. Voorhees (T-Began Aug. 1—3 parts to date—15 cts. each).

24421. Notes on the Strength of Framed Structures as Affected by Elasticity. C. F. Findlay (Eng. L-Began Aug. 10—2 parts to date—30 cts. each).

24476. Books on Bridges. Henry S. Jacoby (R G-Began Aug. 17—2 parts to date—15 cts. each).

24589. The Value of a Water Power. Charles T. Main (M G-Began Aug. 25—Ended Sept. 1—2 parts—15 cts. each).

We supply copies of these articles. See introductory.

DOMESTIC ENGINEERING

Plumbing in Mr. C. P. Huntington's Residence, New York.

AN example of plumbing carried to the highest plane of perfection the art has yet attained is found in the residence of the New York millionaire named in the above title. This magnificent piece of work is to be fully described in detail in *The Engineering Record*, with engravings which reproduce working plans.

The first installment of this description, already published, gives the general features, and it appears that nothing money can procure, or mechanical skill can devise or execute has been omitted in the execution, by a well-known New York sanitary plumbing firm, of this notable piece of work. Of course this review cannot deal with the details of the work; these must be sought in the indexed article. It will only be attempted here to give some idea of its magnitude and quality.

The sanitary arrangements are extensive and complete, conforming to standard advanced metropolitan practice, and embrace kitchen, laundry, and bath and toilet-room service, besides an extensive swimming pool and Turkish bath installation, and the necessary heating boilers, tanks, filters, and pump connections which comprehend a more complicated and extensive system than is provided in some important public edifices. An Ericsson hot-air pumping engine supplies a roof-tank which supplies tank pressure for the upper stories of the building. Besides the pumping engine named there is an auxiliary electric pump, and a double acting Douglas hand pump.

Three-inch water supplies are taken from the street mains on Fifth Avenue and Fifty-seventh street, and each is connected with a 2-inch Worthington meter with inlet and outlet valves. These meters are directly connected by a 2-inch pipe with check valves at each side so that the water cannot escape from one meter through the other. The entire supply can thus be drawn from either main, or the supply for the swimming bath can be drawn from either main, and the rest of the supply from the other main. Alongside each street pressure pipe is an equal sized tank-water cold supply pipe, a hot-water supply and a ¾-inch circulation pipe under both street and tank pressure, making a group of six parallel adjacent pipes on all lines, which are generally carried up in boxes in wall recesses which are afterwards covered with wire lath and inaccessibly plastered in. At the foot of each riser is a controlling valve, and just above it an emptying valve and waste pipe.

Each vertical pipe terminates in an air chamber on top and just below it, on the hot-water pipes, is branched off the circulation return pipe. Then at each floor served, branches from both hot pipes are connected to a cut-off valve from which the distribution branch is taken. Similarly the cold-water tank and street pipes are connected to a cut-off valve from which the distribution branch is taken. All the cut-off valves are set so that when their handles are turned to the right tank pressure is on and street pressure is cut off. When they are turned to the left street pressure is on and tank pressure is cut off, and when they are turned half-way, so as to be at right angles to the wall, both street and tank pressures are cut off.

In the second and third stories are six porcelain roll-rim decorated bathtubs on marble legs, and in other stories are three porcelain-lined roll-rim cast-iron bathtubs. In the boudoir bath-room is a decorated porcelain roll-top sitz bathtub with silver-plated fittings. The other tubs are plain, with nickel-plated fittings, and the bathrooms are finished with white marble and ceramic tiles. On the first floor is a swimming bath, needle bath, shower bath, and two shampoos. In the laundry are four white porcelain washtrays.

This sufficiently indicates the character of the appliances, and those who desire to inform themselves further as to details will find them an interesting study in the art of modern sanitary plumbing.

Nature and Art.

A PAPER contributed to the *Revue Horticolé*, referred to in *Garden and Forest* editorially, has been prepared by M.

Edouard André, who has the honor of being considered the most distinguished living representative of the art of gardening in Europe, according to the publication last named. The paper criticises the present method of making preparatory plans in designing gardens, holding that the designers seem more solicitous about the effect of their composition as it will show on paper than as it will appear when carried out upon the ground itself. The right method, which the author states was the original method, is to search for beautiful results upon the spot itself, and not in an office. He deprecates the excessive care now devoted to theoretical drawing as leading to disillusions in actual work and predicts that this method will soon disappear in practice.

"It will be understood that the tracing of paths, which to-day is thought to constitute in itself the art of garden design, is only a portion of this art, and not the most important portion. It will be felt that, above all, varied scenes must be created within an harmonious whole, and that the means of approach to these scenes should be simply accessory."

These views of M. André are made the text of an excellent editorial in *Garden and Forest*, in which methods of design are critically discussed. Speaking of these methods, Central Park, New York city, is named as being as good an example of "artistic disposition and right relative importance of paths and drives" as can be selected.

"In view of the great beauty of this Park it is instructive to know that none was ever created in a more practical way—less in the office, more in the open air. The design of Messrs. Olmstead & Vaux, as first drawn and accepted, was very different from their design as we see it realized to-day. The former was, of course, adapted, after careful study, to the very peculiar and difficult site in view; but during the long years while the actual work progressed it was perpetually modified in deference to the minuter knowledge gained by its creators. They lived on the borders of the Park and studied its face as a portrait painter studies the face of the sitter. Day by day they reconsidered and recast parts of their scheme, and day by day they reviewed and revised their proposed emendations on the site itself. Thus a great work of art was achieved, and thus only can a great work of landscape art ever be achieved."

The article concludes with a caution against attempting too much work at once in landscape gardening. That is to say it deems it unadvisable that designers should have at the same time too many undertakings of this kind. The opinion is also expressed that no work of this kind can be done with success except through many years of personal superintendence by the designer.

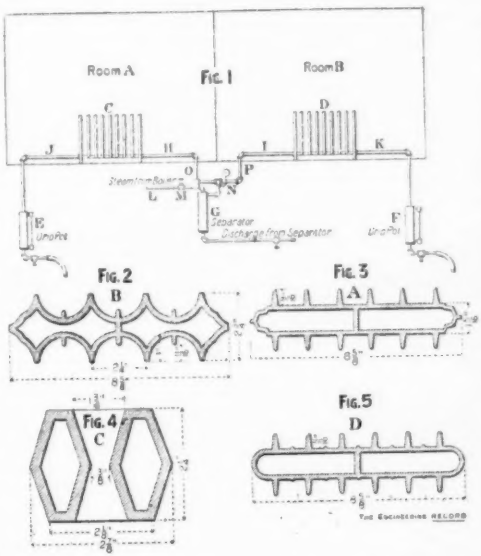
Comparative Tests Between Plane and Extended Surface Radiators.

PROFESSORS J. E. DENTON AND D. S. JACOBUS, of the Stevens Institute of Technology, have recently made a series of tests with a view of obtaining data for a general comparison of the relative value, considered solely with reference to its heating efficiency, of a square foot of extended radiator surface as compared with the same unit of plane radiator surface. A description of methods employed and of the results obtained has been published by the *Engineering Record*. The editors of this excellent publication have kindly aided in the preparation of this review by the loaning of the accompanying engravings illustrating the character of the surfaces subjected to the tests, and the method employed in testing them.

It has become a matter of importance in the purchase of radiators to be able to form some estimate with refetence to the heating effect of a unit of surface of any of the different extended surface radiators on the market, in order to judge wisely whether the price at which it is sold, considered with reference to its heating efficiency makes it more or less costly to use than other kinds. While the tests under consideration do not settle this point for all kinds of radiators, they are valuable, as giving results of careful experiments with several radiator surfaces one of which is plane and of a kind generally accepted by heating engineers as of very high efficiency in transferring heat from its contained steam to surrounding air and objects. In the tests the amount of steam actually condensed in the radiators is taken as the measure of

external heating effect. In this way very exact determinations are possible, when sources of error are, as in this case, carefully avoided. It is necessary that only dry steam be allowed to enter the radiators under examination. To secure the result, a special separator was employed in these tests. It is also essential that all the conditions to which the surfaces investigated are subjected in the test should be exactly the same during the experiments. The following description of the arrangement of the apparatus and of the methods employed are abstracted from the article.

The tests of the complete radiators were made by placing two radiators in adjoining rooms having the same exposure to the influence of the outside atmosphere. There was a single window in each of the rooms, which was opened a certain amount during the tests in order to maintain the temperature at some constant figure. At the top of each room was an opening for ventilation. A screen was placed between the radiators and the window to prevent a direct draft from striking the radiators. The temperature was measured at each side of the radiator. The thermometers were hung about 2 feet from the radiator. and were protected from the action of radiant heat by placing a double screen of tin between them and the radiator. In order to insure dry steam it was passed through a special separator, the blow-off valve of which was left partly open throughout the tests to make certain that no water accumulated in the steam space.



The general arrangement of the two radiators for a test is shown in Figure 1. The radiators C and D were placed in the rooms A and B. High-pressure steam from the boilers passed through the pipe L to the reducing valve M, where it was reduced to the pressure of about $3\frac{1}{2}$ pounds per square inch. It then passed through the separator G and upward through pipe N, from whence it passed through the branch pipes O and P through lengths of hose H and I into the radiators. The water condensed in the radiators passed through the hose connections J and K into the drip-pots E and F. The drip-pots were provided with water glasses. All the connections and the drip-pots were thoroughly covered with non-conducting material to reduce the radiation of heat from them.

In starting a comparative test the water was brought to a certain height in the drip-pots E and F by opening the valves R and S. The valves R and S were then closed so that the water of condensation collected in the drip-pots. At the end of 20 minutes the water was drawn off from the drip-pots through hose submerged in a pail of cold water, and weighed. Each test was continued for one hour or longer, and at the end of this time the radiators were reversed so that D was placed in room A, and C in room B. The test was then repeated. An average of the results for rooms A and B gives the results of the comparative tests contained in table I.

Those who desire to avail themselves of the tabulated results thus obtained must consult the article itself. Two other tables are given which contain valuable data. It was found that the efficiency of the extended surfaces tested varied considerably. It required 1.19 square feet of one kind to condense as much steam as 1 square foot of plane surface. In another case 1.07 square feet equalled in efficiency 1 square foot of plane surface. Between these lim-

its it will be seen there is room for considerable difference. The description of these tests is, perhaps, of greater value as instructing those in the heating trade how they can make such examinations for themselves, than its tabulated results. It is to be hoped that similar tests will also be made with indirect radiators respectively having plane and extended surface, and under conditions as nearly as possible similar to those which attend actual use in heating buildings.

Cheap Sanitation.

AN able legal editorial in *Engineering* discusses the profession of sanitary engineering, regarding it as one of very grave responsibility, as upon the results of the work of the sanitary engineer depend the lives of thousands of persons. The conditions environing the profession are very well stated:

> The art he practises is admittedly so defective that he has no choice but to try and improve it. His task is rendered more difficult by the fact that he has no pecuniary profit to offer his clients to reconcile them to a large expenditure of money. Although there has been a steady and constant progress in sanitation yet its history is largely a chronicle of the substitution of one evil for another, because individuals and public bodies would not undertake the expense of radical reforms, and refused to believe the cheapest remedies were not always the best.

The progress of sanitary engineering from the early days of the cesspool, poisoning basements of houses with leakage, "the cheaply laid sewer" which superseded cesspools but was often itself "half filled with decaying sediment" emitting "evil smelling gases," finding "direct entrance through entrapped pipes into sitting-rooms and bedrooms," and so on through all the steps which have led to the supply of purer potable water and effective drainage with vastly improved ventilation, are then traced in an interesting way up to date.

One of the most interesting features of the article is the credit it gives to the State of Massachusetts for its enterprise in founding an experimental station for the study of filtration of sewage and kindred subjects. Of this it remarks that so great has been its success that to-day no sanitarian's library is complete without the annual reports of the Board of Health of this State, "which results have not only been freely given to the cities and towns of Massachusetts but also to the world and have furnished starting points from which other workers have inaugurated researches which, otherwise, they would not have been able to undertake."

Engineering regards it as hopeless to expect that the local government board will "follow such a good example, as it is utterly opposed to their traditions." It also thinks, were this done, it would be "absolutely certain that the money would be saved many times and—what is still more important—the progress of sanitation would be expedited."

The example of Massachusetts is commended to the notice of the County Councilors in the great manufacturing districts of the north of England. The cost of the Massachusetts' experiments is held to be certainly small as compared with the cost of leaving each town to make its own inquiries and experiments. In short the example of a State Government taking up the subject of general sanitation as Massachusetts has done, is deemed highly worthy of imitation.

INDEX TO LEADING ARTICLES.

24962. Comparative Tests between Plane and extended Surface Radiators (E R-Sept. 8.) 1800 w.

24636. Nature and Art (G & F-Aug. 29.) 1500 w.

*24254. Cheap Sanitation. Editorial (E-Aug. 3.) 2400 w.

19813. American Plumbing (D E-Began Feb.—6 parts to date—30 cts. each).

24231. The Plumber and Electricity (S P-Began Aug.—2 parts to date—15 cts. each).

24434. Engineering and Hygiene (I & I-Began Aug. 10—2 parts to date—30 cts. each).

24542. Plumbing in Mr. C. P. Huntington's Residence. Ill. (E R-Began Aug. 25—1 part to date—15 cts).

ELECTRICITY

Sine Curves of Electromotive Force.

SOME weeks since the London *Electrician* remarked, in respect to alternating current curves of the true sine form, that "the elaborate attempts which are being made by some of the American builders to give this property to their machines is utterly useless and a complete waste of time and energy." In the *Electrical World* (August 25) this problem is discussed pro and con with considerable spirit by two of the leading American authorities on the subject of alternating current phenomena. Charles P. Steinmetz of the General Electric Company says that "an enormous amount of theoretical discussion has been carried on to prove the superiority of the sine-wave for motor work, for the efficiency of transformers, etc., and that mostly by theoretical men who did not have any great chance to prove or disprove their theoretical conclusions by practical experience." In support of his opinion, which agrees with that of the *Electrician*, Mr. Steinmetz gives a table of transformer tests made by himself with two alternating generators giving respectively a sine-wave and a distorted wave, which showed an average difference in efficiency in favor of the distorted wave of over 9 per cent. Tests made with a motor showed that there was no difference that could readily be detected. Hence Mr. Steinmetz concludes that "the superiority claimed for the sine-wave is a mere superstition without actual foundation." Per contra, Professor Harris J. Ryan of Cornell University inquires "whether there is any form for a standard that presents more advantages and introduces fewer constructional difficulties or expenses than the sine form?" He also points out that the sine form is a necessity in case a condenser is employed for supplying the reactance currents to the primaries of induction motors, a plan which has been definitely adopted by one of the most successful builders of alternating motors. In the same journal of September 1, Dr. Louis Bell gives the results of of some experiments of his own bearing on this subject, from which he concludes that very considerable variations from the theoretical sine form of current wave are serious in their effects. He is furthermore of the opinion that the effect of a distorted current is more to be dreaded, commercially speaking, on the line, in a case of long-distance transmission, than in the motors.

Electric Lighting in Great Britain.

ALTHOUGH in a general sense it is probably true that America is very greatly in advance of Great Britain in the diversity and extent of its industrial applications of electricity, yet a careful study of the methods and appliances used in that country reveals some points which our electricians might do worse than to imitate. In the *Electrical World* (August 11, 18, and September 1 and 8) Mr. E. Ray Stevens, of London, gives a useful résumé of the work which has actually been accomplished up to date by the various public lighting companies, with statistical summaries of their annual reports. It appears that the number of central station plants in the United Kingdom owned and operated by companies is now but slightly in excess of the number owned and operated by municipalities. The present tendency seems to be strongly towards increasing the number of municipal plants. As far as figures could be obtained, it appears that all the city plants have been able after the first year of operation to earn interest, taxes, depreciation and sinking-fund charges. In all plants, especially the larger ones, the cost of production has been very largely diminished in proportion to the amount of output, as the actual output increased. The tables given indicate that in Great Britain the municipalities

have been fully as successful as the private companies in operating their plants economically. The average charge to the consumer is given as 12.10 cents per kilowatt-hour for private plants, and 11.54 cents for public plants. This is considerably below the price in this country, which may fairly be taken to be about 15 cents per k. w. h. It appears that very few cities have attempted to illuminate their streets by electricity.

Advantages of Polyphase Electric Motors.

THE fact is now generally accepted that in the transmission of power to a distance by electricity, the alternating current and the alternating motor are practically indispensable. In a paper recently read before the American Institute of Electrical Engineers, Dr. Louis Bell remarks that there has been a tendency to look upon the polyphase motor as a somewhat undesirable resort to which the electrical engineer has been driven by the exigencies of long-distance work. Dr. Bell's own experience as a constructing engineer has, however, gradually led him to the conclusion that the polyphase motor is intrinsically preferable to the direct current motor, and that it is destined to prove a formidable competitor to the latter, not alone in long-distance work, but in all the diverse applications of industry. The comparative merits of the two types of motor are discussed at length, and much interesting information is incidentally given. In its construction, the polyphase motor is singularly free from complexity; the armature winding is simple, and the commutator, a source of endless trouble in many direct current machines, is non-existent. The most powerful currents are insufficient to destroy or even cripple the motor. It is compact and convenient in form and will run equally well in any position. In large units it may be made to weigh as little as 25 to 30 pounds per horse-power. It has been found to endure complete reversal under full load within 10 or 15 seconds, this being the time required to pass from full speed in one direction to full speed in the opposite direction. It is quite insensitive to moderate variations in voltage, but by means of a rheostat in the secondary circuit, its speed may be varied with the same facility and within the same wide range as that of a series-wound direct-current machine.

Cable from New York to Europe.

THE numerous inconveniences incident to the maintenance of land line connections between New York and the eastern coasts of New England and Nova Scotia, have induced the Commercial Cable Company to try the experiment of extending their submarine cable through salt water directly to the Battery, at the southern end of New York city. The *Electrical Engineer* (September 12) contains an interesting account of this work, illustrated with engravings made from photographs taken on the spot. The laying of the shore end of the cable was completed on Sunday, September 2, and the line is now in successful operation. One of the principal recent causes of interference with the land lines has been the stray currents from the trolley railroads in Brooklyn, which at times have completely overpowered the comparatively feeble signals from the sending end of the cable.

A Model Specification for a Municipal Electric Lighting Plant.

IN very many respects, Toronto may justly claim to be one of the model municipalities of the North American continent. Having decided to establish an electric street-lighting service to be owned and operated by the city, the municipal authorities have resorted to the commendable, even if unusual expedient, of having detailed specifications of the proposed plant drawn up by the city engineer, Mr. E. H. Keating, and inviting tenders therefor from the leading manufacturing companies. These specifications are reprinted nearly in full in the *Engineering News* (August 23) and contain much matter of value to the profession. The capacity of the plant is to be 1500 arcs of 9.5 to 10 amperes and 45 to 50 volts, or what are commonly termed 2000 candle-power lamps. From 75 to 100 arcs are to be placed in each circuit. Three 500 horse-power compound condensing engines are

called for, working at a pressure of 140 pounds above the atmosphere. The boilers may be either water-tube or internally fired marine boilers, of a rated capacity of 250 horse-power on a basis of 30 pounds evaporation at 70 pounds pressure, with feed-water at 100° F. Dynamos must have a commercial efficiency of 85 per cent. under full load and be capable of operating for 20 consecutive hours under such load without heating more than 70° above surrounding atmosphere. The insulative resistance must not be less than 1 megohm. Connections between dynamo and switchboard to be made by lead-covered rubber-insulated stranded cables, carried in insulated brass-covered conduits. The outside lines to be strung on white cedar poles, 7 inches thick at the top, and set 5 feet in the ground. Deep-groove glass insulators and No. 6 wire with triple-braided weather-proof insulation are to be used. A lightning arrester is to be provided for each 20 lamps. It is estimated that 220 miles of line-wire will be required. Bids are also invited for a constant-potential arc installation of equivalent capacity, including direct driven constant-potential dynamos. When this contract has been awarded, we shall no doubt be able to learn with considerable accuracy, what ought to be the cost of a first-class arc-lighting plant, of modern type. Moreover, it will be very interesting to gain some authentic information as to the comparative cost of a constant potential and a constant current installation of arc lamps for public lighting, when required to do the same work under exactly similar conditions.

The Computation of Magnetic Leakage in Dynamo-Electric Machinery.

IN designing a dynamo-electric machine, the predetermination of the magnetic leakage has hitherto been regarded as a matter of considerable complexity. Professor Silvanus Thompson, who is looked upon as a leading authority upon this subject, gives in his well-known work a logarithmic formula, originated by Professor George Forbes, which is eminently calculated to strike terror to the heart of the average student, while Kapp, in his "Transmission of Energy" gives two very simple empirical formulæ, which unfortunately are of little value for ordinary purposes. In the *Electrical Engineer* (August 22 and 29, and September 12) Mr. A. E. Wiener gives a series of papers, not yet completed, in which he attempts, and apparently with success, to deal with the problem by simple mathematical formulæ which will enable the leakage factor of a dynamo to be computed for a machine of any form or dimensions within a few per cent. of its actual value. Such predetermination is obviously necessary in every individual case, because that two machines may be of the same general design and approximately of the same size and intended capacity, and yet vary widely in their leakage factor by reason of some difference in the proportion of their essential parts. Even in the same machine the amount of leakage may be considerably varied by substituting armatures of different core-diameters in the same field. To those engaged in the designing of dynamo-electric machines, Mr. Wiener's series of papers cannot but prove of great practical value.

Test of a Closed-Coil Arc Dynamo.

CONSIDERING that there are in the United States nearly 1000 central stations, operating more than 125,000 arc lamps of the type supplied by a single manufacturing company, and probably nearly or quite as many more of various other makes, it is certainly remarkable that so little attention has been paid to the investigation of the characteristics of the peculiar types of dynamo electric machines adapted to this service. Probably nine-tenths or more of the whole number of these machines in use throughout the world are of the open-coil type, but within a year or two, the remarkable effectiveness of some of the later machines of the closed-coil type, has awakened a renewed interest in the study of their performances. In the *Electrical World* (August 18) a paper giving the results of careful tests of such a machine, by R. B. Owens and C. A. Skinner, is published, which is certainly worthy of the attention of those interested in arc-

lighting. The machine tested was a 25-lighter of the Gramme type. Its efficiency under full load was found to be about 84 per cent., which is remarkably high for an arc machine. The efficiency was found to fall off very rapidly with a diminution of load. The regulation for different loads was found to be principally effected by the shifting of the brushes. Graphic diagrams of electromotive force and output accompany the paper. A full abstract of this paper is also given in the *Electrical Engineer* (August 22).

Direct Current Lighting at High Pressure.

ONE of the most unique and technically ingenious plans for lighting a town of moderate size which has come under our notice is that which has for the past two years been in operation in the university town of Oxford, England, and was described by Mr. Thomas Parker in a paper read before the British Association, published in the London *Electrical Engineer* of August 17th. The conditions which confronted the projectors of this plant were by no means favorable to economical or profitable results, and no small credit is due to the engineers by whom they have been so successfully met. In Oxford, the principal consumers are the colleges, and hence anything like a full load can only be obtained during term-time. There is a maximum load for even half the plant only during some eight weeks of the year, and hence the system must necessarily be very elastic to be able to show even fair results. It was also necessary to locate the generating station at a distance of 4500 feet from the center of the area to be lighted, which of course compelled the employment of high-pressure currents. After much consideration, a high-pressure continuous-current plant in conjunction with motor transformers and storage-batteries was decided upon. At the power-house, the currents are generated at an e. m. f. of 1050 to 1100 volts, and are thence conveyed to a distributing station through two pairs of mains insulated with india-rubber, laid underground in iron pipes. Each motor-transformer consists of a field-magnet and an armature with primary and secondary winding, having a commutator at each end. Full details of this apparatus are given in the paper. The secondary mains are made up in two sizes in the form of armored cables. These are laid in a trench under the sidewalks, and are provided with disconnecting branch-boxes, so that any section or street can be cut out. The high-tension feeders to the transformers are of similar cable. At present seven motor-transformers are used in five sub-stations. The storage battery at the distributing station is capable of sustaining a discharge of 120 amperes for eight hours, and takes care of the load from 1 o'clock A. M. until half an hour after sunset. The battery is charged by a small motor generator, giving an output of 100 amperes and 33 volts from its secondary armature, being supplied from the secondary mains at an e. m. f. of 103 volts on its primary. The 33 volts from the secondary armature is put in series with the secondary mains, giving an aggregate of 136 volts, which is sufficient to charge the cells. This is found to be more economical than charging from the secondary mains with a regulating resistance, the total efficiency being 92.5 per cent. At the generating station, three inverted triple-expansion condensing engines are employed, running at 125 revolutions per minute, and driving three separately-excited Elwell-Parker dynamos, each having a capacity of 80 amperes at 1100 volts and 400 revolutions. These are connected to bus-bars, so as to be run singly or in parallel as required. The "load-factor" of the station works out only 5.93 per cent. By this technical expression is understood the ratio of units of current sold to units that could be sold with the lamps always on, viz.:

$$\frac{\text{Metered watt-hours} \times 100.}{\text{Mean watts installed} \times \text{number of hours in the year.}}$$

For the greater part of the year only about half load for one engine is ever required, and in view of this fact the following results of the year's working from July 1, 1893, to June 30, 1894, must be regarded as quite remarkable. The aggregate kilowatt-hours generated were 195,022 and the total metered 122,081, of which 18,303 were

supplied for public lighting, and 2019 k. w. h. were used at the distributing station. The total efficiency of the system was 62.6 per cent.; that of the transformers 76.7 per cent. including losses in mains and resistances, and that of the battery 43.9 per cent. The total kilowatt-hours unaccounted for were 6976 units, or not quite 5.5 per cent. Omitting this loss in computation, the coal used amounted to 6.43 pounds per k. w. sold, costing .752 (1.5 cents) per k. w. The number of 8 c. p. 35-watt lamps installed was 5060 at the beginning and 7774 at the end of the fiscal year. The total cost of all generating expenses, including rent and taxes, was 3.715d. (7.43 cts.) per k. w. delivered to consumers. The total revenue for the year was £3715 8s. 2d. or approximately $15,000, the k. w. consumed averaging 18.2 per lamp throughout the year, for which the average price obtained 7.3d. (14.6 cts.) per k. w. h. It is doubtful if another station can be found in the world of such small capacity and with such wide variations of load in different parts of the year, which can make so good a showing.

How Shall Electricity be Sold?

THE adjustment of a scale of charges for the supply of electricity, in such a manner as to be equitable alike to the small and to the large, to the economical and to the wasteful consumer, has proved in practice to be a matter of no small difficulty. In this country it may be said that rough-and-ready methods are still permitted to prevail to a greater extent than is at all desirable, but in England the matter appears to have been much more carefully studied. In the London *Electrical Review* (July 27, August 3, 10) this subject has been somewhat exhaustively considered by Alfred H. Gibbings, electrical engineer to the Hull corporation. Mr. Gibbings reaches the conclusion that the ideal method of charging is to fix a rate per kilowatt-hour which is definite, and irrespective of the quantity of the consumer's demand; that records should be based upon the daily and not upon the quarterly consumption; that a higher price should be charged during the hours of maximum demand upon the plant, and a lower price at all other times; that the hours of higher price should be definitely fixed, but varied to meet the general lighting hours at different seasons of the year; that all consumers using current during the hours of greater demand should be charged the maximum price and all consumers at other times the minimum price; that no rebates should be allowed to any consumer, but that charges should be based upon net cost of production with a minimum of profit on every k. w. h. generated; that one pair of leads from the supply mains should carry all the current required, whether for lighting or power; and that an automatically acting meter should be provided which will register the current consumed at the higher and the lower rate respectively. Under such a system a consumer would know definitely that he could use as much current as he pleased, at the lower price, right up to the hour at which the higher charge begins to take effect. Moreover, he would know exactly what he was paying on any particular day of the year, whether he might intend to use a similar quantity on any succeeding day or not, and hence it is evident that the inducement for him to become a regular user would be much greater than would be likely with the vague and indefinite inducement of a rebate at the end of the quarter or year. Certainly no system of charging could possibly do more towards eliminating the excessive irregularities ordinarily found in station load-curves, than that of charging a higher price during the daily period of maximum demand. The concluding portion of the paper contains illustrations of a device invented by Mr. Kapp for accomplishing the result referred to, consisting of a simple shunt spanning the meter, which is opened and closed by the action of a chronometer at the proper hours. Obviously the proper ratio between the resistance of the meter and that of the shunt must depend upon the respective rates of charging for current. The discussion is one of great practical importance, and will repay careful study by central station managers.

A Technico-Legal Puzzle.

AMONG the various perplexing problems

which have arisen to vex the souls of electric railway managers in this country, there is none, it is safe to say, which has occasioned them more serious concern than that of the damages alleged to have been sustained by gas and water companies from the extensive corrosion of their pipes by the electrolytic action of the stray electric currents from the generators of the railway companies. If ascertained remedies are adopted with reluctance, or with only moderate success, an appeal to the courts will inevitably be taken at no distant day. In the *Street Railway Gazette* (August 11), the legal status of the problem is examined at some length by R. D. Fisher. Mr. Fisher refers first to the litigation between the telephone and the electric light companies. Both occupied the public highways by legal rights, the telephone having been the first comer, and its service having afterwards been seriously crippled in many places by the inductive action of the electric-light lines. In Nebraska, the courts have decided that telephone wires already in a street must be protected, to the extent at least, of compelling the electric-light conductors to be kept at a certain distance therefrom. Perhaps the most important point yet decided in the case of a telephone company against a street-railway company, is that of the Supreme Court of Ohio of recent date, in which it was held in substance that the franchise of a telephone company to use the public streets is subordinate to the right of the public therein for purposes of travel and transportation, and that these uses are materially facilitated by the application of electricity to street-railways. Now it would seem by analogy as if the same principle ought to apply to the case of the gas and water-pipes. If we assume that the public has the right to avail itself of all new and improved modes of travel which may from time to time be discovered, then it would seem to follow that a franchise granted for this purpose must confer a right paramount to the prior franchise of a water or gas company; and hence if the operation of a street railway by electricity interferes with the working of a gas or water company, the latter must protect itself as best it can by readjusting its methods to meet the new conditions. If these conclusions are legally sound, then it would appear that the conflict between the gas and water companies and the electric railways must ultimately be settled by the ingenuity of inventors rather than by the skillful or technical efforts of lawyers and courts. The whole question nevertheless appears to be surrounded by grave difficulties, and is likely to occupy the attention of the courts to a considerable extent at no distant day.

Alternate vs. Direct Currents.

AMONGST electrical engineers there remain a few, chiefly of the old pioneers, who have not yet grasped the advantages possessed by alternate currents over continuous currents in systems of electric supply, says Professor Silvanus Thomson in his paper read before the British Association, in the *Electrician* (London) of August 24. Superstitions still linger that alternate currents are less easy to manage, or are less economical, or are more dangerous, or are less readily measured than continuous currents. There is a special superstition that they cannot drive motors. Such superstitions once set afloat, die hard. And, sad to relate, they are sedulously fostered by a few interested persons who ought to know better. The all-important fact to the electrical engineer, that the economic transmission of electric energy to long distances depends upon the use of high pressures, is absolutely independent of the nature of the current, whether continuous or alternating, but the peculiar advantage of the latter arises from the circumstance that high pressures cannot be used in houses without being transformed to low pressures, and hence a system which employs only a stationary transformer of two coils of wire wound on an iron core must be preferable to one which requires moving machinery of more or less complexity to accomplish the same end, Professor Thomson sums up the various advantages of alternating currents in a lucid and forcible manner. His remarks may be summarized by saying that all troubles arising from commutators and brushes

are avoided; there is less trouble from leaks in the distributing circuit than in case of direct currents; the danger to life with equal voltage is less; alternate currents are capable of regulation by inductive resistances which do not waste energy; when applied in phasal systems, they enable a central station to furnish current from a single set of mains for almost any possible requirement; while a still further advantage about which even electrical engineers are as yet almost wholly unenlightened, is the capacity of alternatic currents to operate electro-magnets which maintain a constant pull upon their armatures through a large range; it being even possible to produce a greater pull at a distance than when in close proximity. This circumstance obviously introduces into electro-mechanism a new element hitherto undreamt of. Finally, recent researches have rendered it certain that the regulation of pressure in an extensive network of conductors, instead of being made more difficult where motors are extensively used, as was feared by some engineers, will actually be more easy, provided the motors are of the over-excited synchronous type. With such possibilities open in the future for alternate current working, and with such advantages in respect to motive-power over continuous current working, Professor Thomson thinks it can hardly be doubted that, save in a few special cases, the vast majority of central stations will henceforth be operated by alternating currents.

In the same number of the *Electrician*, the editor takes up his cudgel in behalf of the direct current and presents the opposite side of the case in picturesque and forcible language. Admitting that at least in a certain sense, the controversy between the alternating and direct current is at an end (it certainly is in the United States), the *Electrician* contends that this is not because direct currents have no chance, but rather because it is a question to be determined in each particular case, at what point on the radius from a supply station the direct current must be dropped. Professor Thomson is criticised for bracketing low pressure with direct currents, as though the laws of nature forbade a direct current of 5000 or 10,000 volts. Eighteen months ago, Dr. Fleming had proved as well as figures could prove, and as yet without refutation, that taking the all-day efficiency of a three-wire feeder one mile long delivering 24 k. w. at 200 volts, and the all-day efficiency of a 24 k. w. transformer and losses in a double 7/16 primary cable one mile long, there was practically nothing to choose between the annual costs. Nevertheless, the *Electrician* concludes that it is probable that a majority of future stations will generate alternate currents, for the reason that the larger cities have already adopted the direct current system as best adapted to their needs, leaving the promoters of alternate current undertakings to make the best they can of the less compact and less profitable territory still open to them. There is much barren soil which no direct current man cares to till, but from which the alternating man may with care reap a golden harvest. The engineering difficulties are not insurmountable, and the scientific difficulties for which such ingenious remedies are proposed, will disappear of their own accord. They are merely kept before us by scientific men who enjoy them.

Economy in the Boiler Room.

In a paper recently read before the Northwestern Electrical Association, Consulting Engineer John C. McMynn discusses this somewhat trite, but nevertheless, most misunderstood and neglected subject. He gives a well-proved formula for computing the approximate cost per horse-power of boilers under different conditions, and appends a set of tables compiled for R. W. Hunt & Co. showing the cost of evaporating 1000 pounds of water with different fuels at different prices. This paper is of no less value to managers of other steam plants as well as to those engaged in the production of electricity.

INDEX TO LEADING ARTICLES

Lighting.

24212. The Coming Electric Light (M S P-Aug. 4.) 1300 w.

24278. An English Lighting and Power Plant. James H. Killey (C Eng-Aug.) 2800 w.

*24314. The Municipal Electric Light Station at Hanley. Ill. (E E L-Aug. 3.) 3300 w.

*24422. The Electric Lighting of Portsmouth and Southsea. Ill. (Eng L-Aug. 10.) 3800 w.

*24439. The Mensing Arc Lamp. Ill. (E R L-Aug. 10.) 500 w.

*24440. The Lighting of Public Streets and the Cost (E R L-Aug. 10.) 1200 w.

24526. Specifications for Electric Street Lighting Plant for Toronto (E N-Aug. 25.) 5000 w.

24531. Association of Edison Illuminating Companies of the United States (E W-Aug. 25.) 3000 w.

24535. Incandescent Arc Street Lamps in Brooklyn. Ill. W. T. Hunt (E A-Aug. 25.) 900 w.

24553. Electric Illuminating Plant of the Herzberger Insane Asylum, Lichtenberg, Germany. Ill. (W E-Aug. 25.) 2000 w.

*24606. Continuous-Current Distribution of Electricity at High Voltage.—A Description of the Lighting of the City of Oxford. Thomas Parker (E E L-Aug. 17.) 2500 w.

24734. Electricity in Church. Ill. (E W-Sept. 1.) 1200 w.

*24776. Electric Lighting of Arundel Castle. Ill. (E R L-Aug. 24.) 2500 w.

24889.—$1. Unipolar Dynamos for Electric Light and Power. F. B. Crocker and C. H Parmly, with Discussion (T A I E E-June and July.) 8000 w.

Serials.

16631. The Scientific Study of Arc Lamps. Rankin Kennedy (E R L-Began Oct. 6, 1893—8 parts to date—30 cts. each).

22131. The Incandescence Lamp. A. Bainville (E R L-Began May 11—6 parts to date—30 cts. each).

24018. A Bolometric Study of Light Standards. Clayton H. Sharp and W. R. Turnbull (E N Y-Began Aug. 1—Ended Aug. 22—3 parts—15 cts. each).

24194. Electric Lighting in Great Britain. E. Ray Stevens (E W-Began Aug. 11—4 parts to date—15 cts. each).

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*24317. Electric Power, Heating and Lighting. G. Binswanger (E E L-Aug. 3.) 1500 w.

24344. Test of a Closed-Coil Arc Dynamo. Ill. R. B. Owens and C. A. Skinner (E N Y-Aug. 15) 2200 w.

24367. The Pittsburg Reduction Company's Electric Plant at Niagara Falls. Ill. (E E N Y-Aug. 15) 1100 w.

†24398. Commercial Power Development at Niagara. Ill. Ernest A. Le Sueur (P S M-Sept.) 8200 w.

24637. General Electric Railroading. G. P. Hachenberg (E R N Y-Aug. 29.) 1100 w.

*24755. Notes on Electric Power, with Special Reference to Works Driven by Electricity in Belgium. D. Selby-Bigge (E E L-Aug. 24.) 1800 w.

24823. The Modern Dynamo. Gilbert Donaldson (Pr-Sept.) 1000 w.

24890.—$1. Diseases of Dynamos.—Compiled and Arranged by C. D. Parkhurst (T A I E E-June and July.) Table.

24899. Electrically Operated Factory at South Milwaukee, Wis. Ill. (W E-Sept. 8.) 1200 w.

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11560. Electric Motive Power. Ill. Albion T. Snell (El-Began March 17, 1893—19 parts to date—30 cts. each).

21777. Cost of Electrical Energy (El-Began April 27—Ended Aug. 3—5 parts—30 cts. each).

23866. Dynamo Electric Machinery. Ill. Edwin J. Houston and A. E. Kennelly (E W-Began July 21—6 parts to date—30 cts. each).

24437. Elementary Theory of the Induction Alternating Motor. Ill. Rankin Kennedy (E R L-Began Aug. 10—1 part to date—30 cts).

24508. Magnetic Leakage in Dynamo-Electric Machinery. Alfred E. Wiener (E E N Y-Began Aug. 22—2 parts to date—15 cts. each).

24536. Principles of Dynamo Design. Newton Harrison (E A-Began Aug. 25—3 parts to date—15 cts. each).

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24554. The Attempt to Extend the Telephone Monopoly (W E-Aug. 25.) 5000 w.

*24564. The Telegraph and the War in the East. J. Morris (El-Aug. 17.) 1100 w.

*24566. Signalling Through Space. W. H. Preece (El-Aug. 17.) 3000 w.

24629. The Evolution of the Telephone Switchboard. Ill. Arthur Vaughan Abbott (E E-Sept.) 7500 w.

†24759. Rubber Insulation for Underground Wires in England.—Views of Manufacturers and Engineers (I R W-Aug. 15.) 4000 w.

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*24933. The Pacific Cable (E R L-Aug. 31.) 1700 w.

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23307. The Development of the Electric Telegraph. Stephen Vail (E N Y-Began July 4—Ended Aug. 22—8 parts—15 cts. each).

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*24204. Lightning and Lightning Conductors. Oliver J. Lodge (E Mag-Oct.) 3000 w.

24652. Steam and Electric Cableway for Logging and Canal Boat Towing. Ill. (Sc A-Sept. 1.) 1000 w.

*24257. Electric Welding. Benjamin Alfred Dobson (I C T-Aug. 3.) 3500 w.

*24334. Electrical Storage Batteries. J. Appleton (L H P-July.) 3800 w.

24340. The Storage Battery from the Standpoint of the Purchaser. Townsend Wolcott (P A-Aug. 15.) 2100 w.

*24465. Preparation of Solution for Accumulators. H. M. Sayers (El-Aug. 10.) 1300 w.

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24509. The Resonance of Electrical Circuits. William A. Anthony (E E N Y-Aug. 22.) 1300 w.

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*24585. The Obach Dry Cells (E R L-Aug. 17.) 1500 w.

24641. Recent Observations on Earth Currents. W. Finn (E E N Y-Aug. 29.) 1000 w.

24644. The Equipment for Electrical Engineering Laboratories. D. C. Jackson (E E N Y-Aug. 29.) 3700 w.

24663. Preliminary Experiments for Comparing the Discharge of a Leyden Jar through Different Branches of a Divided Channel. Lord Kelvin and Alexander Galt (E N Y-Aug. 29.) 800 w.

24733. Tesla Effects with Simple Apparatus. Ill. H. M. Martin and W. H. Palmer, Jr. (E W-Sept. 1.) 1000 w.

*24756. Experiments for Improving the Construction of Practical Standards for Electrical Measurements.—Report of the Electrical Standards Committee of the British Association (E E L-Aug. 24.) 6800 w.

*24773. The Recent Accidents Occasioned by High-Tension Currents (E R L-Aug. 24.) 3000 w.

*24775. The Electro-Deposition of Cadmium (E R L-Aug. 24.) 900 w.

*24779. Some Advantages of Alternate Currents. Silvanus P. Thomson, with Editorial (El-Aug. 24.) 6500 w.

*24780. On the Construction of Delicate Galvanometers. Arthur Schuster (El-Aug. 24.) 900 w.

*24781. The Equality of the Velocities of Propagation of Very Short Electric Waves in Free Space and Along Conductors. Ill. M. Dufour (El-Aug. 24.) 600 w.

*24782. On Magnetization Produced by Hertzian Currents.—A Magnetic Dielectric. M. Birkeland (El-Aug. 24.) 900 w.

24837.—$1.25. Electric Transmission of Power and Electric Lighting, from the Point of View of the Mechanical Engineer. Alexander B. W. Kennedy (J A N E-Aug.) 12500 w.

24887.—$1. Some Storage Battery Phenomena. Ill. W. W. Griscom, with Discussion (T A I E E-June and July.) 13500 w.

24888.—$1. Continued Discussion of Paper by Alexander Jay Wurtz on "Discriminating Lightning Arresters, etc." (T A I E E-June and July.) 12000 w.

24901. Storage Battery Litigation.—Judge Green's Decision (W E-Sept. 8.) 2000 w.

24904. How to Deal with Apparent Death from Electric Shock. Ill. Augustine H. Goelet (E W-Sept. 8.) 1800 w.

*24941. Alternate Current Resonance. Ernest Wilson (El-Aug. 31.) 900 w.

Serials.

17546. Recollections of Werner von Siemens (E N Y-Began Nov. 22, 1893—Ended Aug. 22, 1894—12 parts—15 cts. each).

22059. Practical Notes on Dynamo Calculation. Alfred E. Wiener (E W-Began May 19—15 parts to date—15 cts. each).

23439. On Impulsive Current-Rushes in Inductive Circuits. Alfred Hay (El-Began June 29—Ended Aug. 10—6 parts—30 cts. each).

24090. The Various Methods of Charging the Public for Electricity from a Central Station. Alfred H. Gibbings (E R L-Began July 27—Ended Aug. 10—3 parts—30 cts. each).

24198. Action of a Transformer with a Condenser in Parallel with the Secondary. Ill. Frederick F. Bedell and Albert C. Crehore (E W-Began Aug. 11—3 parts to date—15 cts. each).

24584. The Electro-Chemical Relations of Carbon at High Temperatures. E. E. Brooks (E R L-Began Aug. 17—Ended Aug. 24—2 parts—30 cts. each).

24642. Protection from Lightning (Abstract.) Alexander McAdie (E E N Y-Began Aug. 29—1 part to date—15 cts).

24826. The Rise of Electricity. J. Mount Bleyer (E R N Y-Began Sept. 5—1 part to date—15 cts).

24884. Electricity in the Modern City. Thomas Commerford Martin (J F I-Began Sept.—1 part to date—45 cts).

24942. The Potential and Current Curves of Different Types of Alternators, and Their Influence on the Candle-Power of Alternate-Current Arcs. G. Rössler and W. Wedding (El-Began Aug. 31—1 part to date—30 cts).

INDUSTRIAL SOCIOLOGY

Present Industrial Problems in the Light of History.

ASKED by the editor of *The Forum* to "deal with the causes of discontent and their true significance; with the possible lines of improvement; with the effect of the factory system; with the existence of class feeling and with danger to liberty—if there is any—in existing combinations of capital in trusts or corporations, or combinations of men in trades unions and other associations, Mr. Edward Atkinson accepts what to most thinking men would appear a very large contract, and writes upon all these topics with his accustomed grasp of thought, and in his usual graceful, vigorous style.

In seeking for causes of discontent he goes back to the feudal system, and traces social changes up to the present age in historical sequence. He finds the secret of England's dominating power in "the very factory system with which we are struggling." He finds the cause of Napoleon's failure to permanently reconstruct the map of Europe, in failure to recognize "the principle that in the great commerce among nations all men serve each other's needs."

He thinks Napoleon "was conquered by the English money power." He pays an eloquent literary tribute to the power of the almighty dollar—well merited, since it can accomplish so much in these latter days not only in buying and transporting food, but in influencing and controlling legislation, and purchasing police protection for law breakers. A dollar can do a good deal nowadays.

Yet there is discontent. There ought to be discontent. There are wrongs affecting this man who earns a dollar a day. There are wrongs for which society as a whole must be held responsible; wrongs due to putting ignorant men in places of power, who tamper with the standard of value; wrongs due to putting selfish men in places of power, who pervert the force of taxation to private ends; wrongs due to those who, by neglect of their political duties, permit cities to be misgoverned and legislators to be suborned. The discontent which does to some extent pervade great masses of people is a reflection of these wrongs, which those who are affected by them know not how to remedy. If men of intelligence fail to recognize the fact that a part of the discontent which now actuates great masses of people is well grounded, then the remedy may be a very rough one, but it will be complete.

The greatest change in the social condition Mr. Atkinson finds in what Carey called the "societary circulation of commodities"; that is to say, distribution of products made possible by enormous increase of facilities for transportation and communication. As the United States is "the only machine-using nation which possess the power of producing food, fuel, and iron in excess of any possible want for generations to come," Mr. Atkinson regards it as certain that "whatever may be the delay or obstruction, this country will become within a very short time the greatest agricultural, manufacturing, ship-building, and commercial country in the world." In the arts including the production of iron and steel, the textile arts, the working of metals, glass, pottery, etc., Mr. Atkinson thinks strikes more likely to occur than in others. "If all this work were done on the individual principle, and the effort were made to give an equal supply to that we now enjoy, there would be no time left for anything else." The benefits therefore, of the factory system are considered plain by Mr. Atkinson. "Evils consist in our long hours of work of a very monotonous kind, to some extent destructive to individualism."

Mr. Atkinson regards with favor all sorts of industrial organization, and attributes labor troubles in the United States to want of organization of labor. He has no fear of trusts, regarding them, with some exceptions, rather as beneficial than otherwise. He thinks that when all English speaking peoples "are united in reciprocity of trade, all the evil powers of the world

must go down before us." If we can eradicate from legislation the error "that in commerce what one nation gains, another loses, almost all the evils that can be cured by legislation will vanish."

The Relations of Employer and Workman.

THE masterly address of Hon. Carroll D. Wright, United States Commissioner of the Department of Labor, read at the Eighth Annual Convention of the National Association of Builders recently held at Washington, and printed in the proceedings of the Convention, contains thoughts upon the subject worthy the careful study of all sociologists as well as of those who, not claiming to be sociologists, are yet anxious to arrive at correct views. The *American Architect* has printed the address. The speaker starts out with the fundamental proposition that the interests of labor and capital are not identical. He says:

There never was a greater fallacy. They cannot be identical any more than the interests of the purchaser and the seller can be identical, except in so far as one accommodates the other. The interest of the seller is to secure as large a profit as possible. There is a relation existing between the two, but the relation is reciprocal; it is not identical for both parties. Being reciprocal what does it involve?

He next discusses the subject of harmony in the labor question:

It is only men who create and make uniform things. You can cast a million bullets without being able to discover the slightest difference between them. You can make a thousand pairs or a million pairs of shoes exactly alike. You can produce millions of tons of iron or steel with no difference except such as chemical analysis may show; but the Creator has made variety the rule in all His works.

Now this means much in the labor question, and it involves what I like to call the psychology of it, which means that men's minds differ as much as their views, and that in order to bring any harmony into the labor question you must be able to recognize the difference in the other man's mind. While units differ, interests differ also, and this leads every association which cares anything for the elevation of its own character and every body of men which cares anything for its standard of life to understand the means and methods by which the associated units can be brought into harmonious action.

Difference in "the tone and thought of the age" must also be taken into account. "Individualism, until within a generation or so, was the ruling element—the ruling philosophy. To-day it is all altruism." Of this spirit of the age and its bearings on the labor question the following forcible language is employed:

It is the altruistic spirit as against the individualistic that rules to-day. We cannot get rid of the influence of the tendency if we will; it is utterly impossible to throw yourselves outside of the tendency of the age in which we live. This tendency has brought us from what the political economists call status, to the condition of contract. This is the very greatest element in the development of the labor question from a condition of status, fixed under the influence and the customs of society and of industry, to one of contract, whereby each man is at liberty to make such contract with his fellowman as he chooses.

Now the only difficulty of this relative to the labor question is that the workingman is not always at liberty to make such a contract as he chooses because he is bound by economical conditions out of whose influence he cannot reach. Therefore, the freedom of contract, which is an expression belonging to this age, is one that does not wholly mean exactly what it says. The employer, trained in business practices, independent in his position, must, of necessity, under the present condition of industry, suggest the terms of the contract, and the other man, who seeks to benefit by them, must come to them because he cannot reciprocate by suggesting; if he does, then comes trouble. If the two parties cannot reach the high plane of industry and free contract, then comes the strike, then come the labor difficulties, then come all the wars of industry which we have seen for the past few years, which are as great and terrific almost on one side of the water as on the other.

The whole labor question is regarded as a "psychological one rather more than it is an economical one"; and through a train of thought indicated by this expression the speaker reaches the subject of compulsory arbitration, in the discussion of which he substantially repeats what he said in his Chautauqua address referred to in the preceding review, and shows the utter hollowness of all expectations based upon such a system.

The advocacy of voluntary arbitration,

and of perpetual boards of arbitration not meeting too frequently, with instances of greater or less success in the settlement of labor difficulties through the agency of such boards, completes an address remarkable for its eloquence as well as for its comprehensive grasp of the entire subject.

Arbitration Under Compulsion.

THE social questions involved in the causes of strikes, the wisdom or unwisdom which looks upon them as remedies for real or fancied wrongs, arbitration as a substitute for strikes and a remedy for the disagreements between employers and employés which are the usual excuses for inaugurating them,—these, and all the relations of labor to capital,—to the commonwealth,—to human progress, are "burning questions" and will continue to be so till a happier day shall discover some ameliorating element that will allay existing discontent.

Leading magazines and reviews are actively dealing with, and obtaining contributions to the literature of these topics from the most eminent writers and profound thinkers.

Out of all this thought and discussion must come, in due time, such suggestions of reform in social relations as will afford relief from the embarrassments, perplexities and obstructions to commerce and industry under which the civilized world now labors, and the dangers always inherent in any great change in the industrial status such as the material progress of the age has wrought in the distribution both of labor and of capital.

Six out of eleven of the papers printed in the *Forum* for August were upon sociological subjects. The August number of the *Nineteenth Century* also contained a strong paper entitled "The Labor War of the United States" and the magazine literature for September is running over with discussions of these and kindred topics. This fact is mentioned as indicating the preëminently absorbing interest of these questions at the present time as evidenced by current periodical literature.

The methods of strikes and boycotts originating abroad, have been developed in this country to a point that justifies the appropriateness of the title just quoted from the *Nineteenth Century*. The daily columns of newspapers teem with accounts of strikes, now of so frequent occurrence that scarcely any issue goes to press without some news of this kind. Weekly papers, also, even those devoted to specialities in arts, industry and science, are joining in the debate upon social questions. For instance, here is the *Iron Trade Review* taking up in a leading editorial the subject of "Arbitration Under Compulsion" and handling it in a very able manner.

This proposed remedy for strikes has been regarded by some as not only promising a complete remedy for all industrial troubles, but as a perfectly feasible system, easy to apply and administer,—in fact a sugar-coated specific for the prevention and cure of all social disorders arising from want of assent of either employers or employés to objectionable demands.

It does not seem to be impressed upon the minds of the most ardent advocates of this method, that there may be some disabilities that render the scheme impracticable.

Its advocacy, which just now appears to be pressed forward without due consideration, is, in the view of the writer of the article cited, "inspired by the belief that in the one wage controversy that has attracted public attention of late, compulsory arbitration would have given the advantage to the men."

"It is almost certain that a compulsory arbitration law would be declared unconstitutional on the first attempt to enforce it against unwilling employers or employés; but even viewing it from the broader ground of equity and the requirements of latter-day social conditions that the constitution-makers could not have anticipated, it is unwise and indefensible It is claimed, in answer to some of the fatal objections raised, that the advocates of the system believe in it only up to the point of compelling the parties to come into court, but do not believe in enforcing the court's decision. Of what avail, then, would be such an expenditure of money and such a use of judicial machinery, if the effect is to be purely sentimental? Public opinion can furnish sentiment in plenty, under

existing conditions, but it will effect nothing when it opposes the stronger forces that regulate industrial operations. Public sentiment seemed to be with the miners in the strike of a few months ago, but it did not save them from defeat."

In support of these views the editorial makes a strong argument and reinforces it by quotations from utterances of Hon. Carroll D. Wright, U. S. Commissioner of Labor, and ex-Senator George F. Edmunds of Vermont, to show that, even were the system declared constitutional by the higher courts, it would, if adopted, quoting from Commissioner Wright's speech delivered at Chautauqua a few days ago, "force all the industries of the country into trust formation, or the country into a state of socialism."

The whole argument is, in conclusion, summed up in this strong editorial by the following comprehensive paragraph:

"In brief, the proposition involves state management of private business, on the one hand, and state control of the labor of men's hands, on the other. Any denial of this statement can only be based on the assumption that the arbitrament is to go unenforced,—and that is equivalent to the advocacy of compulsory arbitration as a farce."

The cause of industrial distress lies too deep to be reached by such legislative makeshifts, or by palliatives of any kind whatever; and it is not surprising that those who perceive this should listen with some impatience to the clamors of would-be reformers whose suggestions are about as valuable as that of garrulous old women would be in a case of disease taxing the highest skill of the most accomplished physicians.

Conciliation, Arbitration, and Mediation.

ANOTHER industrial paper, *The Colliery Guardian*, makes room for a long report of the Royal Commission on Labor, prepared by its secretary, in which the systems of Voluntary Conciliation and Arbitration, and that of Legislative Mediation and Arbitration, and their operation and results in the British Colonies, United States, and foreign countries are reviewed. In this document it is contended that the two subjects, Conciliation and Arbitration, must perforce be treated simultaneously, because in the settlement of trade disputes these methods are so frequently "combined in the procedure of a single tribunal or board which has power to pronounce a decision on the failure of the disputants to effect a settlement," yet the radical distinction between these methods is fully recognized, and even emphasized by a quotation from the report of the New South Wales Commission on Strikes:

"When conciliation has failed it is time for arbitration to begin." A further quotation from the same document defines the distinction:

The function of a conciliation agency is to bring about a voluntary agreement between the parties to a dispute, while the function of an arbitrator is to determine the merits of the case and give a positive decision.

The report regards voluntary conciliation and arbitration as extremely rare, and judges from the experience of the British Colonies, the United States, and European countries that "the success of such methods presupposes both a high state of organization, at least on the side of the employed, and a disposition on the part of the opposed associations to negotiate on friendly terms."

The views expressed of the operation of these methods in the United States will be of most interest to American readers but are too voluminous for transcription. Labor organizations in America are thus spoken of: "The comparative weakness of labor organizations appears to have been an obstacle in the past to the formation of joint committees on the English system."

The Late Railroad Strike and Its Lessons.

THE manner and methods of conducting the great strike of the American Railway Union headed by Mr. Debs, which was perhaps, taken in all its aspects, the most remarkable attempt ever made in this country to coerce capital by obstructing commerce, are severely criticised in an article written by Hon. R. G. Horr for the New York *Weekly Tribune*. The intimidation of men who, induced by their ne-

cessities to accept positions vacated by strikers, thus "seeking to obtain an honest living by honest labor," is called by Mr. Horr a "cruel and outrageous practice." Such intimidation was a marked feature of the strike under consideration.

It is also charged by Mr. Horr that "a strike seldom occurs in this or any other country where the strikers quietly withdraw from their labor, go peaceably to their homes, and refrain from interfering with people who are ready and willing to do the work thus abandoned. Notwithstanding Mr. Debs published every morning for public reading a carefully worded statement advising his followers to refrain from violence and to let all their actions conform to the law," Mr. Horr charges that he was at the same time, by secret telegrams and private advice, encouraging, aiding, and abetting the obstruction of trains and the transportation of passengers, freight and the mails. Mr. Horr asserts that Mr. Debs knew that the statements he thus published were "false in every particular." The failure to inaugurate the strike which Mr. Debs announced would take place through the aid of Mr. Sovereign, the head of the Knights of Labor in the United States, and in which it was asserted "1,000,000" people, scattered all over the United States would lay down the implements of industry and would abandon the immense army of production is noticed. The failure of the call of Mr. Sovereign to aid the strike in any important way is attributed to the fact "that even organized labor had refused to join in a useless crusade against law and order."

"The leaders of the strike found themselves face to face with the Government of the United States as well as with the law-abiding people of this entire nation. They failed because they ought to have failed. There was no reason or sense in what they attempted to do. Even if the Pullman Company had been entirely in the wrong in the original controversy that could in no way justify the attempt to cripple business and endanger life throughout the entire nation. The instance does not exist, it will never exist, where the innocent should be punished for the sake of reaching somebody else, whether that somebody else is guilty or not."

With reference to "the power to call out great bodies of men from their accustomed labor and to deprive large numbers of families of their daily support," Mr. Horr maintains that this course "ends in so much suffering, so many heart burnings, and so many antagonisms that it should be exercised with the greatest care and should never be trusted to the decision of any one man." The establishment of the fact that the "people of the United States believe in law and order" and that the "burning of cars, ditching of trains, the destruction of innocent lives, will not be tolerated in this republic is deemed by Mr. Horr "to be worth all it cost" in the great strike, and he regards it as "now well understood that the business of this nation must not be destroyed to gratify the ambitions or whims of an egotistical leader."

A Later Adam.

IN the present current discussions upon social reform it would seem that all who can think and write acceptably are seeking to air their views. The universal interest in sociological problems is not only thus evinced, but a great deal of thought flows into byways, nooks, and corners of literature, so to speak, such as the correspondence columns of the daily press, and short criticisms of articles appearing in the technical publications; as, for example, in the Department of Comment and Criticism in this Magazine. This floating discussion, is the truest obtainable reflection of the popular mind. Lord Macaulay found in the files of old newspapers and in ballad literature of the period covered in his History of England a rich mine of material that reflected popular manners, thought, and feeling. A short article written by Mr. Fred Woodrow, and printed in the *Age of Steel*, expresses an idea that is gaining currency in the popular mind.

This is that the monopolist, as well as a kind of selfishness characteristic of the period, and pervading society from top to bottom, are the product of industrial changes that have increased the intensity of the struggle for existence. Mr. Wood-

row starts out with the proposition that every "change in our social industrial condition produces its special type of man. The original Adam was a creation; the later gentleman is an evolution."

The monopolist of to-day with sovereignty, the stuff of which he is made and the spirit that vivifies it have their nativity in the age that produced him. In fact he is as much a product as he is a sinner, the difference between him and the smaller fry being that he carries under one hat what a thousand others have only in the shape of mincemeat. The man is simply a type of a system. To reform this gentleman we must commence by reforming ourselves, and it is just here the cure of some of our industrial and commercial diseases must commence. It is very easy, and in fact is quite the fashion, to raise our voices against the cupidity and despotism of monopolies and corporations and at the same time be ready to seize the biggest egg on the table for our own breakfast, and compel a sick wife to take in washing to pay for own beer. The difference in such a case between a monopolistic monstrosity and ourselves is one of size but not of spirit. He can swallow a Jonah, and we choke at a sprat.

Of the monopolist, called by Mr. Woodrow "the" Later Adam: he writes:

Of course in this age of so-called equal rights, personal freedom and a considerable amount of paper religion, it is not in fashion to be without some respect for law and humanity. If there is any iron in our souls it must have a velvet skin, and if we are Shylocks in business we must enclose that gentleman in Samaritan cloth. Hence the later Adam. He builds towns, endows libraries and donates to charities, and yet in a business sense his soul would find hotel accommodations in a gooseberry. He loves money and the world loves him because he has got it. He is the god of the crowd, not for what he is but for what he has. We have evolved this type of man in an age where the sinner and the saint are considerably mixed. It is not his money or his power that makes him a wart on the public body. It is the abuse of these things, and blindness to their responsibilities; so the larger the tree the broader its shadow.

MR. ROBERT LEW SEYMOUR in the *Chautauquan* (August) in an article entitled "What Shall be Done with Anarchists?" deprecates hasty and passionate treatment of these disturbers of the public peace. "Russia would bring a Debs up with a round turn. He would be given free transportation to and a life job in the mines at the utmost confines of the Empire," and he thinks that Germany, Austria, England, France, and other European nations would handle such an agitator as Debs "in an exceedingly expeditious manner for half the provocation he has given here." He attributes our toleration of Anarchists to our love for and faith in American institutions as embodied in the Declaration of Independence. He does not, however, think it was the intention of those who formulated the Declaration of Independence "to convey the idea that all men were equal in the sense of being equipped with uniform power, either physical or mental, but that they were equal in so far as all are guaranteed a fair chance to make the best possible use of their respective abilities." On these fundamental propositions he has written a very entertaining article.

ALL those who are somewhat muddled in their views with regard to bimetallism should read the article on "Political Economy and Bimetallists," printed in the *Bankers' Magazine* (August), and which is an extract from a lecture delivered by Professor Nicholson before the British Economic Association last June. The subject is dealt with in a peculiarly pungent manner. The following sentence in the lecture, which was greeted with laughter, is a sample of Mr. Nicholson's style: "Mr. Ruskin tortured his imagination and the English language to express his loathing for what nobody ever was or ever wrote. The economist, to his view, was a one-eyed flat-fish with the side on which there was an eye always in the mud." To Mr. Ruskin's writings about political economy, together with those of Carlyle, written according to Mr. Nicholson "in a severe attack of dyspepsia, physical and mental, and wherein the Scotch philosopher applied the term dismal to the men and the thing, "forgetting or ignorant of the high eulogium passed on Adam Smith by Robert Burns," Mr. Nicholson attributes the attitude of indifference, as compared with

an earlier generation which journalists of to-day assume toward economic questions. The object of the lecture he states to be the effort to "impress upon journalists the advantage and the duty of becoming thoroughly familiar with economic methods and principles, apart from the particular problems with which they were called upon to deal."

"THE Policy of Labor" is another strong article discussing the labor movement from an English point of view, printed in the *Contemporary Review* (August), and contributed by Mr. Clem Edwards. It discusses the effect of elementary education and the institution of cheap press with reference to their political fruits. He thinks the social revolution had begun when workmen could read. On these lines the article is carried out to its conclusion, which is that the next few years will witness a great growth of labor representation.

"CHICAGO'S Message to Uncle Sam" and "A Review of the Chicago Strike of '94," the former by Prof. Frank Parsons, and the latter by Walter Blackburn Harte, both in the *Arena* for September, are perhaps the two most radical articles on the labor question that have appeared during the month. They are written in very opposite styles, but are both exceedingly entertaining." They serve to point the remark made in a previous review to the effect that the industrial situation is the theme of paramount interest now presented to the thinking world, and that the questions raised by the situation can never be dismissed from attention till they reach solutions acceptable to the popular mind.

INDEX TO LEADING ARTICLES.

*24202. The Industrial Development of Chile. Ill. Courtenay DeKalb (E Mag-Oct.) 3000 w.

*24208. Evidences of a Revival in Business.—As Reflected in the New York Market (A Series of Interviews.) (E Mag-Oct.) 3000 w.

*24209. Britain and the United States.—The Cost of Living Compared. Andrew Carnegie (E Mag-Oct.) 3000 w.

*24210. Political Economy and Bimetallists (B M-Aug.) 3800 w.

*24211. The Chicago Object-Lesson. Hartley Withers (B M-Aug.) 1300 w.

24285. Arbitration under Compulsion. Editorial (I T R-Aug. 9.) 900 w.

†24372. A Week on a Labor Settlement. John Law (F R-Aug.) 3500 w.

†24373. The Gold Standard. Brooks Adams (F R-Aug.) 10000 w.

†24375. The Labor War in the United States. J. S. Jeans (N C-Aug.) 4200 w.

24390. The Late Railroad Strike and Its Lessons for Workingmen. R. G. Horr, in N. Y. Tribune (B I S-Aug. 15.) 1800 w.

†24406. The Policy of Labor. Clem Edwards (C R-Aug.) 5300 w.

*24428. Conciliation, Arbitration and Mediation in the Colonies, United States and Foreign Countries.—From the Final Report of the Royal Commission on Labor (C G-Aug. 10.) 9200 w.

24471. The Relations of Employer and Workman. Carroll D. Wright (A A-Aug. 18.) 5200 w.

*24522. What Shall Be Done with Anarchists? Robert Lew Seymour (Ch-Sept.) 2000 w.

*24560. Canadian Tariff Changes (B J T-Aug.) 3800 w.

*24561. Tariff Changes and Customs Regulations—Russia, Norway, The Netherlands, Belgium, France, Spain, United States, Mexico, Costa Rica, Labrador, Gambia and Victoria (B T J-Aug.) 5000 w.

*24608. The Lessons of Recent Civil Disorders. T. M. Cooley (F-Sept.) 9000 w.

*24609. Present Industrial Problems in the Light of History. Edward Atkinson (F-Sept.) 5500 w.

*24610. The Profit-Sharing Labor Unions of Antwerp. J. H. Gore (F-Sept.) 2000 w.

*24611. How to Bring Work and Workers Together. Jacob A. Riis (F-Sept.) 3000 w.

*24718. The American Tariff and British Industries. Editorial (I & I-Aug. 24.) 1500 w.

†24790. Chicago's Message to Uncle Sam. Frank Parsons (A-Sept.) 1500 w.

†24791. A Review of the Chicago Strike of '94. Walter Blackburn Harte (A-Sept.) 18000 w.

24793. A Plan to Increase the Circulation of Currency and Make Better the Roads of the Country. Simon Schriver (G R-Sept.) 2200 w.

*24913. The Wealth of the United States. Editorial (E-Aug. 31.) 2000 w.

*24915. The Alien Question. Editorial (E-Aug. 31.) 2000 w.

*24917. The Law of Trade Combinations. Frederick Pollock (C G-Aug. 31.) 4200 w.

*24926. Trades Unions and Strikes. Editorial (I & I-Aug. 31.) 1000 w.

24963. A Later Adam. Fred Woodrow (A S-Sept, 8.) 700 w.

We supply copies of these articles. See Introductory.

MARINE ENGINEERING

The Marine Boiler of the Future.

PAPERS read before the Institution of Naval Architects at the last three meetings of this body, held respectively at Cardiff, London, and Southampton, together with the discussions elicited by these papers, in the opinion of *The Engineer*, expressed editorially, "supply ample evidence that an important change in marine boiler construction is imminent."

The old Scotch boiler, notwithstanding its wide use, has also many notable defects; and latterly the type of water-tube steam generators has been undergoing a kind of rapid evolution that has brought it to the front. Not only engineers and naval architects, but also shipowners are beginning to regard it with favor. The article finds an analogy in the present status of marine boilers and that of steam-engines twenty-five years ago, when the advantages of compounding engines were under active debate. That debate resulted in the trial of compound engines, but at first, with caution and hesitation, as the water-tube generators are now being tried. Of the period of compound engine introduction, the article quoted says:

Setting aside such vessels as the *Thetis* and *Propontis*, which worked at fairly high pressures, numerous ships could be named in which pressures of 30 pounds and 35 pounds were used with compound engines and surface condensers. The success attained was such that engineers took heart of grace and ventured to make boilers carrying 60 pounds. No harm followed. These boilers did not blow up or burn out, and they gave the compound engine a chance. Then came thick steel plates and corrugated flues; and so pressures crept up, and the triple-expansion engine was among us almost unawares. Improvement after improvement was made in the engine but the type of boiler remained the same. From first to last the advance was made with difficulty. There were unceasing disputes with the Board of Trade, which very vigorously opposed the effort to carry high pressures in the Scotch, or indeed in any other kind of boiler. When pressures of 160 pounds had been reached a lull ensued, and for about ten years very little has been done in the way of change. Various causes have, nevertheless, been silently at work; among these may be mentioned the extreme lowness of freights, which has rendered economy of fuel imperative. The demand for high speeds; the adoption of forced or assisted draught; the failure of Admiralty boilers; all these things have operated to stimulate invention—and what is more to the purpose, to induce engineers and shipowners to consider inventions however audacious, instead of putting them aside almost without a thought.

That we are now in the midst of a change in marine boiler engineering, and that the engineer or shipowner who maintains that things are good enough for him as they are "will find himself out of the race in a very brief period," is the assertion made in this article, in proof of which, it sets forth undeniable facts.

It is a quite familiar fact that none of the older class of steamers can be made to pay. We doubt if there is now running any screw steamer, of fair size, with compound engines. Mr. Asplin's engines in Messrs. Leyland's steamers are, it is true, compound; but they are really, if we may say so, triple-expansion engines with the intermediate cylinder suppressed, working with high ratios of expansion and high pressure. Just as the compound engine and 80 pounds steam cannot compete with the triple-expansion engine and 160 pounds steam, so it will be found that these last cannot compete with engines working with 200 pounds steam, generated in boilers differing more or less from the Scotch boiler. This pressure is not in extended use yet, but it will be in a very short time—possibly by the end of the year. The question is, what will the new steam generator be? At the present moment every marine engine building firm of importance throughout the kingdom is either patenting, experimenting with, or building water-tube boilers of some kind. It remains, of course, to be seen which of all these will survive the test of a life at sea. Possibly the

water-tube boiler of the future has yet to be invented or discovered.

Various kinds of water-tube steam generators are next reviewed, and the general advantages of the system are discussed comprehensively. Among these "the saving in weight and space—often of quite as much value as a considerable saving in coal," is used as an answer to the assertion that any enormous augmentation of economical efficiency is not claimed for any of the water-tube boilers in use The conclusion is that the "unmodified Scotch boiler is going out of fashion, and something else is coming in. What that will be remains to be seen."

Taxation of American Shipping.

NOT insignificant among the disabilities under which American shipping interests now labor is the burden of unjust taxation imposed for state and local purposes in different ports. If we wish to "see ourselves as others see us," it is well to read foreign papers and periodicals occasionally. An abuse that is in its nature local, and yet is of such importance as to incite comment in the foreign press, is editorially treated in *Transport*, the article being in the nature of a review of a memorandum report prepared by Mr. Eugene Chamberlain, U. S. Commissioner of Navigation. This document contains statements of fact not familiar to the public outside of marine circles. That the inequalities in this kind of taxation must seriously affect the commerce of different ports will appear from the following abstract from Mr. Chamberlain's report:

Bath, Maine, levies more taxes on its shipping than are paid by the North German Lloyd Company on over $15,000,000 of shipping to Germany. Portland levies more taxes than the Cunard Company paid to Great Britain last year on nearly $9,000,000 of shipping. Portland taxes are greater than those paid even by Gloucester, Mass., or Detroit, Mich., on about $15,000,000. Taxation in Maine appears to be three times heavier than in California, double that of Georgia, and many times greater than in England, France or Germany. Indeed, none of the three great Transatlantic lines could have been operated under the Maine tax laws, as those laws would have levied taxes on them greater than the amount any of those companies paid as dividends last year.

Taxes levied on shipping at Gloucester last year were more than those paid by the North German Lloyd Company on over $15,000,000 shipping to the German government; or those paid by the Cunard Company on over $9,000,000 of shipping to the British government; and the taxation at that port for State and local purposes is double the rate imposed at San Francisco or Savannah, Georgia, on shipping.

Taxation on shipping at Charleston, S. C., is five times heavier than that levied by Great Britain or Germany.

While Alabama exempts from taxes vessels engaged in the foreign trade, taxes on coasting vessels at Mobile last year were double those paid by the Pacific Steam Navigation Company to the British government on over $6,500,000 of vessel property.

Taxes levied on shipping at New Orleans last year were more than the Compagnie Generale Transatlantique paid on $22,000,000 of shipping to the French government; than the two great German lines, the North German Lloyd and the Hamburg-American Line paid on their combined shipping, valued at over $25,000,000; and were three times the taxes paid by the Cunard Co. on over $9,000,000 to the British government.

San Francisco levied last year $85,675 taxes a sum within $600 of the combined taxes paid by the Cunard Line, the Hamburg-American Line, the North German Lloyd and the Compagnie Generale Transatlantique to their respective governments, on their combined shipping accommodation, upwards of 700,000 tons of the best steel and iron steamships in the world, valued at upwards of $58,000,000.

Taxes on shipping for State and local purposes at Detroit were in amount virtually what the North German Lloyd paid on over $15,000,000 of shipping to the German government, and more than the Cunard or the Hamburg-American Lines to their respective governments on over $9,000,000 each.

Milwaukee levied taxes on shipping greater than those paid by the Cunard Company to the British government on over $9,000,000 of shipping.

Taxes levied on shipping at Cleveland, Ohio, last year, were more than the combined taxes paid to the German, French, and English governments by their three great steamship lines, the North German Lloyd, the Compagnie Generale Transatlantique, and the Cunard Line on their $48,000,000 of shipping.

The "evil preëminence of the State of Maine in respect of these dues" is noted. The article then quotes from the *Maritime Register* some remarks upon a species of illegitimate taxation existing in the port of New York, much of which has been recently exposed by the recent investigations of a commission appointed by the New York State legislature.

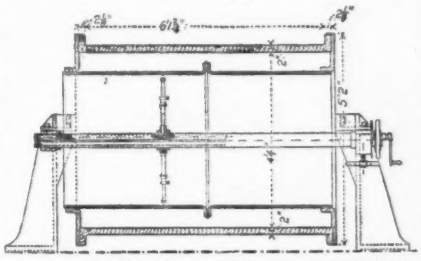
That a ship coming to a port like New York should, in addition to the rent of a pier, have to pay a harbor master, or a dock master, whose salary is paid by the city, a fee for permitting the vessel to have a berth at all, should pay the customs inspector for performing his official duties, for which he is paid by the Government, should give the police officer a gratuity for doing his duty, would seem to form a system of plunder impossible in any great seaport. Yet it has existed in New York for years and has helped to make this port one of the most expensive in the world. In each case and with each vessel the amount in the aggregate may not seem large. Fifty dollars would cover it in many cases no doubt, but we have known these robberies to have reached three times that amount. The amount, however, is not the only consideration. That such extortions should exist at all is a disgrace and the hurt of New York. There is no reason whatever why they should be paid, and it speaks but illy for our abilities properly to conduct the business of the port that such bribes and blackmail are not wholly prevented.

It is fair to say with reference to the extortions spoken of in the last paragraph, that since their exposure they have largely ceased, at least as regards those imposed by the police.

Tests of Resistance of Boiler Furnaces to External Pressure.

THE results of a series of tests carried out by the German naval authorities during the years 1887 to 1892, with a view to obtain data relating to the strength of furnaces of internally fired boilers have been put in tabular form and will henceforth become standard. These tests were made at the imperial navy yard at Dantzic, and having been described in the *Zeitschrift des Vereines Deutscher Ingenieure* by Prof. C. Bach, the *Engineering News* has printed a translation, which, together with an inset illustrating the text, places these data at the disposal of those who cannot read the German language. The engraving here reproduced will give a good idea of the apparatus employed in making the tests.

The testing apparatus consisted of a cylinder of forged steel, 52 inches in diameter, 6 feet 6 inches long and 2 inches thick, with end flanges to which ring flanges were bolted, a tight joint being made with red lead. The furnaces to be tested were riveted to these ring flanges, as shown on our inset sheet. The annular space between the tube and the cylinder was connected with hydraulic pressure pumps and two pressure gages were attached. To measure the deformation of the furnace under pressure, a shaft was run centrally through the cylinder, as shown, and a radial extensible arm, carrying a graduated scale, could be revolved by the crank on the shaft and could be traversed upon it by a screw, as shown. The index on the radial arm read to .004 inches. In making the experiments, the hydraulic pressure was increased in increments of about 71 pounds per square inch, until the first deforming of the furnace occurred, accompanied by a sudden fall in pressure. After measuring the deformation, the pressure was again raised until further increase became impossible by excessive leakage through the joints, due to deformation or through cracks in the metal. Between $12,000 and $14,000 was expended on the series of experiments.



APPARATUS FOR TESTING STRENGTH OF FURNACES.

Hitherto computations for strength to resist collapsing pressure have been based upon data supplied by the celebrated Fairbairn experiments, whose results were originally printed in the Transactions of the Royal Society of 1858. Of these and the need for additional data *Engineering News* says they "were made with very thin tubes of small diameters. Of 32 tubes tested, 26 had a thickness of 0.043 inch, five of 0.13 inch, and one was 0.25 inch

thick. The average diameter was 10 inches.

At present boiler furnaces are made from ¼ to 1 inch thick and 2 feet to 6 feet in diameter. It is somewhat doubtful, therefore, how far the results of the Fairbairn experiments are a safe guide in computing the strength of boiler furnaces at present in use. The tests at the Danzig Navy Yard were made with furnaces of 0.30 inch to 0.60 inch in thickness and 37 inches to 40 inches in diameter. The furnaces tested included 14 plain furnaces, 4 corrugated furnaces, and 1 Purves ribbed furnace. All the furnaces tested were new.

There can be no doubt as to the value of the data thus obtained. Henceforth they will probably be embodied in text books of marine and mechanical engineering, as those obtained by Fairbairn were, and thus become permanently a part of the literature of engineering. For the present, those who wish to use them may obtain them from the article itself, which gives, for plain boilers, the furnace number; material; inside diameter in inches; deformation pressure in pounds per square inch; maximum permanent change of radius in deformed rings in inches, as observed before deformation took place; pressures in pounds per square inch at which the maximum permanent changes of radius in deformed rings occurred; thickness of plates in inches; thicknesses at place of deformation; tests of material; limit of elasticity along fiber in pounds per square inch; the same transverse to fiber; tensile strength, in pounds per square inch transverse to fiber, per cent. of elongation in 8 inches, along fiber, and length of boiler ring in inches.

The Portents of Marine Construction.'

THE display of models at the Antwerp Exhibition supplies *Engineering* with materials for an editorial. Under the title given above, this editorial makes a comprehensive examination of the relative merits of screws and paddles for vessels of light draught, such as steamers for navigating the English Channel, etc., and also touches upon the water-tube boiler question without however entering upon its merits. On this head it remarks:

"Very many have formed a conviction; and it will be interesting to notice whether Mr. Howden with his array of facts convinces them, or ultimately recognizes that while his system has proved itself eminently satisfactory for vessels almost of all types, and gives a higher evaporative efficiency for the weight than is got under ordinary conditions, the reawakening of the interests in, and the efficient working of present types of, water-tube boilers, is destined to have an important bearing in the future of all types of high-speed vessels for the question of weight is pressing more and more hardly upon the designer."

With reference to paddles and screws, and the necessity for minimizing draught, it says "it is the limited draught of many harbors, notably those of Europe, which is the chief obstacle to more extensive adoption of the screw." With reference to the modern tendency to substitute twin screws for paddle wheels an interesting statement of speeds at which screws have been run is given in the following excerpt:

"The reduction of the diameter to suit the low draught involves a high revolving speed, but this only demands careful design and workmanship. The three Channel Island vessels of the London & Southwestern Railway Company, the *Frederica*, *Stella*, and *Lydia*—for instance, have engines running at a piston speed of 935 feet per minute, making 170 revolutions per minute, and these vessels run both in season and out of season, and without giving any trouble, so that, as we have said, it is but a matter of design and careful workmanship. And here it may be noted that while the piston speed is high—that of the *Daring* at 29½ knots was 946 feet per minute—the number of revolutions may be increased in the future, enabling a smaller propeller to be used. Still the limit in this respect is not distant. . . . . The necessity for minimizing draught, as we have said is predominant. The Newhaven to Dieppe harbors limit the draught to about 8 feet 6 inches, in few channel harbors can it be allowed to exceed 10 feet at low water, and the naval architect has reason on his side when he urges that this in itself is a limitation to speed. Indeed, it has been said by an experienced naval architect that nearly all our Atlantic steamers might have been a knot or two faster if the draught in their case had not been limited to 28 feet."

An advantage of paddle steamers, besides limitation of draught, is mentioned as consisting in the great expanse of prom-

enade possible, which, with a short two or three hours voyage in fine weather, is an attraction. For this reason it is thought the paddle steamer will continue popular, although for channel service it is likely to be gradually superseded by the twin screw vessel.

AN interesting description of Commodore Barron's prow ship is given in the *Scientific American* of Aug. 18. A model of this queer ship was exhibited in the rotunda of the Capitol at Washington in 1836, and is now preserved in the Seamanship building at the Naval Academy, Annapolis, Maryland. The ship was proposed to be composed of solid logs; to be about 230 feet long and 80 feet in width, and was to float on account of the lighter specific gravity of the timber, 6 to 8 feet above the water. It was to have an iron prow, the whole structure being bolted together in the strongest possible manner. The object of the vessel was to destroy men-of-war by ramming them with the iron prow or beak, and doubtless, a blow struck by this enormous mass, going under steam at full speed, would have been a death-blow to most ships of its period. It is evident from the description that Commodore Barron had a good conception of the principles that have since been embodied in the iron beaks of warships, and that had his vessel ever been built, it would have performed nearly everything the inventor claimed for it. It is asserted that this is the first steam ram ever proposed. It is well to preserve such mementos.

INDEX TO LEADING ARTICLES.

24270. Our Naval Flag Room (B J C–Aug. 11.) 1500 w.

*24296. The Cockerill Company's Shipbuilding Yard at Hoboken, near Antwerp. Ill. (M E–Aug.) 1800 w.

*24300. Recent Experience with Cylindrical Boilers and the "Ellis and Eaves" Suction Draught. F. Gross (P Eng–Aug. 3.) 1800 w.

*24310. How to Make the Ship Canal a Commercial Success.—A Question of National Importance. B. J. Belisha (R P L–Aug.) 2000 w.

*24313. Auxiliary Machinery of a Modern Cruiser. Frederick Arsenius (S L–Aug.) 2300 w.

24359. Commodore Barron's Prow Ship. (Abstract.) George H. Preble (Sc A–Aug. 18.) 1600 w.

24385. Tests of the Resistance of Boiler Furnaces to External Pressure. Ill. (E N–Aug. 16.) 1200 w.

24391. A Serious State of Affairs.—Want of a Large Dry Dock. Editorial (Am S–Aug. 16.) 1000 w.

24414. The Solarometer. Ill. (E M J–Aug. 18.) 1200 w.

*24419. The Portents of Marine Construction. Editorial (E–Aug. 10.) 2700 w.

*24423. The Marine Boiler of the Future. Editorial (Eng L–Aug. 10.) 1800 w.

*24458. Taxation on American Shipping (Tr–Aug. 10.) 1300 w.

24518. Cairo as a Seaport (Sc A S–Aug. 25.) 1100 w.

*24617. The West India Dock (Tr–Aug. 17.) 1600 w.

24646. The Cost of the New Navy (Sc A S–Sept. 1.) 300 w.

*24661. The Ports and Harbors of Great Britain.—Cardiff. Ill. (E Rev–Aug. 20.) 2200 w.

*24697. The Boiler Question in the Navy. Argus (E–Aug. 24.) 4400 w.

24833.—$1.25. Review and Experimental Test of the Steam Plant of the Steamship Iroquois. W. C. Selden (J A N E–Aug.) 5000 w.

24834.—$1.25. The Qualities and Performances of Recent First Class Battleships. W. H. White (J A N E–Aug.) 5500 w.

24835.—$1.25. Albatross. Chief Engineer Isherwood (J A N E–Aug.) 5000 w.

24838.—$1.25. The French Torpedo-Boat "Chevalier." (J A N E–Aug.) 1400 w.

24839.—$1.25. Trial Data of Steamship. J. M. Lincoln (J A N E–Aug.) Table.

Serials.

16636. Marine Engine Design (M W–Began Oct. 6, 1893—13 parts to date—30 cts. each).

21969. The Shark and the Sailor. A. Ewbank (I E–Began April 14—15 parts to date—45 cts. each).

23761. The Vibrations of Steamships. John H. Macalpine and H. C. Flood (E–Began July 13—Ended Aug. 10—3 parts—30 cts. each).

24263. The Design of Mail Steamers, with Special Reference to Their Use for War Purposes. J. H. Biles (Eng L–Began Aug. 3—Ended Aug. 17—3 parts—30 cts. each).

24365. The Kutubdia Lighthouse. J. H. T. (I E–Began July 14—Ended July 21—2 parts—45 cts. each).

24868. American Ships for American Commerce (Sea–Began Sept. 6—1 part to date—15 cts).

24695. The Guns and their Mountings of Spanish Belted Cruisers. Ill. (E–Began Aug. 24—1 part to date—30 cts).

We supply copies of these articles. See introductory.

MECHANICAL ENGINEERING

The Gas Engine in France.

THE best practice in the construction and management of gas engines is discussed in the *Boston Journal of Commerce*, in an abstract from a French report which appears to entertain the belief that this kind of motor is destined to supersede steam engines for small powers in many places. The increase in the range of power of gas engines which through steady progress has now been reached, with the probability that gas engines developing even greater power will be forthcoming, makes the information thus given timely and important.

The article is an abstract from a report made by a committee of a French technical society appointed to investigate the use of gas engines and report thereon. The report appears to regard the displacement of stationary steam engines by gas engines as "only a question of time."

The machines of 1867 consumed from 95 to 124 cubic feet of gas per horse-power per hour. Now machines are regularly made which use only 17.65 cubic feet, as for example, the 8 horse-power Charon motor with single cylinder. This is a remarkable advance; and along with it the use of gas engines has spread; and, further, the tendency is toward a steady increase in the size of the engines. The four leading gas engine makers in France (Charon, Crossley, Niel and Otto) sold, in 1890, 192 engines of 734 horse-power; in 1891, 344 of 1157; in 1892, 516 of 2099; and in the first five months of 1893, 372 of 1821 horse-power. The displacing of steam engines by gas engines thus appears to be a mere question of time; and gas engines solved the problem of the distribution of power in a very convenient way.

But is the motor itself likely to undergo any fundamental changes? There have not been any such since 1889. The proportion of the total heat of explosion lost incidentally is still practically not less than 80 per cent.; and it seems that when the loss from one cause has been reduced that from another has generally increased. There is a limit to the heat which can be recovered as work; not more than 38 per cent. can, even theoretically, be recovered, as Witz has shown; and this means that we cannot expect ever, even in theory, to run gas motors on less than 13.35 cubic feet per horse-power per hour, as an irreducible minimum. But with these data the temperature of the out-flowing gas is 1353° F.

The question of utilization of this waste heat is then considered and discussed with reference to various types of machines, and attempts to convert more of the heat into available work.

The Present Standing of the Gas Engine.

THE same issue of the *Boston Journal of Commerce*, containing the abstract above reviewed, has also an editorial in which some of the inconveniences and drawbacks in the use of these motors are noted. The great increase in the units of work developed is noted, and three 100-horse gas engines used for electric lighting at a power station for an electric lighting plant in Danbury, Conn., U. S., with success and economy for two years, are cited with reference to the difficulty experienced in starting up gas engines in general, and notably gas engines of large size. The editorial was evidently written in a spirit of skepticism regarding the probability that stationary steam engines are ever to be superseded by gas engines. Mention is made of some 200-horse gas engines, now in regular use. Of these and other large engines, the article proceeds to say:

So far these large installations have mostly been placed on the premises of gas works, to do electric lighting, but their success so far as economy is concerned is claimed to be very pronounced and doubtless will lead many other gas plants to use them, and to introduce them further. The engines are, however, far from being so much of a success in every particular as we believe will be necessary to bring them into general use for large powers, nor their economy so low in comparison with the steam engine as the friends of the gas engine claim. The difficulty of starting the large engines cannot be gainsaid. In a recent description of the plant of the Danbury, Conn., Gas Co., with three 100-horse engines, quite an amount of space is necessary to describe the extensive gear necessary to start and stop the engine, and before this comes into use, the shaft

to be driven is first started by means of a steam engine of 15-horse power. This is a drawback at the start, and we do not believe the economy of the plant will actually hold a very satisfactory comparison with a steam plant of similar dimensions. A gas engine of this kind will use at a low calculation 17 cubic feet of gas an hour for each horse power and this is an indicated horse power. As the friction of the engine is considerable, between 30 and 40 per cent., an important item for consideration, by the way, the cost in gas for a useful horse power would be about 22 feet of gas, and would cost in Boston 2.2 cents. A steam engine of similar capacity would produce a horse power readily on 20 pounds of steam, or 2½ pounds of coal, and allowing 20 per cent. for friction would require 3 pounds of coal per horse power per hour. This 3 pounds of coal at $4 per ton would cost but 6/10 of a cent, leaving a very large margin to offset any extra costs that could be figured against the steam engine.

Machine For Testing Lubricating Oils.

A "machine specially designed for the use of testing laboratories, manufactories, railways and all users of lubricating oils to whom it is of importance to be able to ascertain in a quick reliable manner the relative antifrictional efficiencies of competing oils" is described in the *Safety Valve*. This machine was designed by Prof. A. Martens, director of the Royal Technical Testing Laboratory at Charlottenburg, Berlin. It is said to be the outcome "of many years' experience in testing oils with a larger machine of the same type designed by Prof. Martens." An illustrated description of the machine in detail is given. The principle of the machine is that of the deflection of a pendulum rod which has a bearing on a revolving journal, to which bearing the lubricant is applied. The amount of the inclination from the perpendicular caused by the friction of the journal upon its bearing is transmitted by a pin and slot connection to a slide carried by rollers and having a scale from which the coefficient of friction can be read off directly. Provision is made for testing the temperatures of the lubricant by means of a thermometer placed in a convenient position for that purpose. A diagram illustrating the principle of the machine is here reproduced. "The extent of throw or oscillation of the pendulum is the direct result of the frictional resistance of the film of oil between the bearing strips and the revolving and testing journal, and is consequently a measure of the coefficient of friction at the observed pressure and temperature."

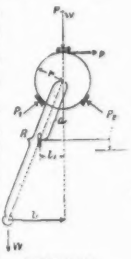


DIAGRAM TESTING OILS.

If r be the radius of the testing journal,

R = distance of center of gravity of pendulum bob from center of testing journal,

a = distance of slide-actuating pin from center of testing journal,

W = weight of pendulum bob,

w = weight of entire pendulum,

$P = P^1 + P^2$ = pressure exerted by compressor upon the bearing strips, and

x = be the coefficient of friction, then

ρ = the frictional resistance at the circumference of the testing journal $= x\,(P + P^1 + P^2 + w) = x.\ Q$,

l = throw of pendulum bob,

l^1 = throw of slide,

$$\rho\ .\ r = W\ .\ l;\ \text{and}\ l = \frac{R}{a}$$

Then

$$x\ .\ Q\ .\ r = W\frac{R}{a}\cdot l$$

or

$$x = \frac{W}{r\ .\ a}\cdot\frac{R}{Q}\cdot l^1.$$

These constants having been determined by experiment, the value of x can be recorded automatically by means of a pencil carried by the slide and pressed by a spring against a strip of paper, which is caused to travel at a suitable speed in a vertical direction past the point of the recording pencil, by means of mechanism actuated from the main horizontal shaft of the machine. An accurate and clear idea of the relative antifrictional values of different oils may thus be formed by comparing the curves obtained in testing such oils, with the characteristic curve obtained by testing refined, acid-free, rapeseed oil under the same conditions of pressure and temperature.

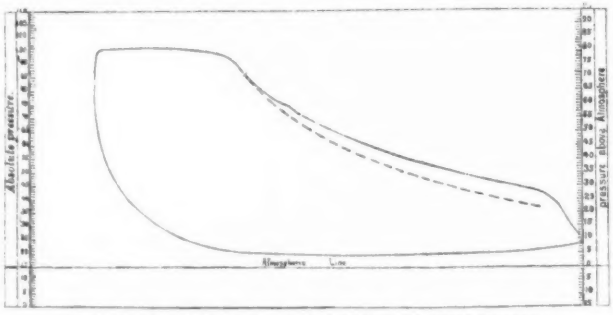
Engine Cylinders.

AN abstract from the Chief Engineer's report to the Engine, Boiler, and Employers' Liability Insurance Company, Limited,

Manchester, England, is printed in the *Mechanical World*. The abstract is made from that part of the report which pertains to steam engines and deals with the design of steam engine cylinders. The examination of such cylinder drawings as have been submitted to the writer's consideration during recent years has led him to believe that he may, without presumption, and perhaps with advantage to steam users, draw attention to a point which, though it materially affects economy of working, seems to be frequently overlooked in cylinder designs.

The point in question is the influence which clearance has upon cylinder condensation. Hitherto clearance has been regarded as injurious rather on account of its waste of steam during the period of exhaust. It is a fact that cylinder condensation is a function of the entire interior surface of steam engine cylinders between the valve inlet and the discharge outlet and that the effect of clearance upon condensation has probably not been appreciated at its full value by designers of steam engines.

The writer of the report named makes it very clear that condensation, occurring as it does more in the early part of the stroke and during the admission period, must be more largely affected by clearance than has generally been supposed. Especially in steam engines where the cut-off is short, the clearance must be in any case a considerable percentage of the exposed interior surface which, previously cooled during the exhaust period, is again reheated at the expense of the steam during the induction at the beginning of the stroke. It is during this period that the widest difference exists between the temperature of the steam and the interior surface of the cylinder with which it is brought in contact. Consequently the transmission of heat depending upon difference of temperature must be greater during the induction of the steam than in any other equal time in the stroke. More than this, the temperature difference existing at the very beginning of the induction rapidly decreases as the cylinder becomes reheated. The very first portion of the cylinder with which the steam on entering is brought in contact is that of the clearance, which thus becomes the first factor in condensation. From these considerations it is evident that in engines where the total clearance is large, as is the case with many compound, triple, and quadruple expansion engines, the clearance must greatly affect their efficiency.



INDICATOR DIAGRAM FROM COMPOUND TANDEM ENGINE.

By way of experimental proof of the truth of this proposition the author cites a case of a compound tandem condensing engine.

The diameters of the cylinders were 12 and 22 inches; the stroke of the pistons 2 feet 6 inches; the speed 80 revolutions per minute. The cylinders were completely jacketed, and the high pressure cylinder had Corliss valves. The boiler pressure was 80 pounds, and the number of expansions varied from 12.9 to 19.2. Surely such an engine should have been economical. Yet the rate of consumption was found on trial to vary from 20 pounds per indicated horse power per hour with steam in the jackets to 21 pounds with the jacket supplies shut off.

The indicator diagrams (one of which, from the high pressure cylinder is here reproduced) suggest the cause. The slow rise of the compression curve, the appearance of late admission (although the valves had nearly 3-16 inch lead),

and the full expansion curve, all point to excessive initial condensation, and, in fact, from 51 per cent., or, roughly speaking, one-half of the steam entering the cylinder was condensed during the period of admission. Why was the condensation so excessive? Rather ask, why was the surface exposed to the entering steam so great?

From drawings accompanying the report, it is computed that the volume described by the piston previous to the cut-off is 0.29 cubic feet. The surface required to contain this volume is "a belt of the interior of the cylinder 4.4 inches long and having a diameter of 12 inches." This is the irreducible minimum of surface, 2.72 square feet, the ideal at which the designer of the cylinder should have aimed. The actual amount including clearance is 7.9 square feet of which the clearance surface or the surface exposed to the steam before the piston begins to move at all is no less than 6.75 square feet, or 35.5 square feet of surface to each cubic foot of clearance volume. The report then goes on to point out how this extra surface has been brought in. This part of the report which cannot well be condensed and which is too long for transcription, is a valuable lesson to young draughtsmen in the design of steam engine cylinders.

Power Losses in Transmission Machinery.

AN abstract of a paper read before the American Society of Mechanical Engineers at its recent meeting in Montreal, and printed in the *Safety Valve*, is one of the best contributions to current mechanical literature. The voluminous and useful tables, seven in number, embodied in the paper contain a mass of information which must have caused the author a great deal of labor to prepare, and which, while exceedingly valuable to mechanical engineers in general, must prove especially so to those interested directly or indirectly in power transmission. The main point which the author, Mr. William S. Aldrich (who also prepared the abstract of his paper for the journal quoted), brings out in his able paper, is "that the high speed automatic engine, directly connected (or better, directly coupled) is best adapted to meet sudden and very great variations in electric power plants, while the well-known type of Corliss engine seems best adapted to steady loads." As introductory to such discussion he makes the following statements:

"Cards taken every ten minutes cannot possibly show the real variations of power in an electric railway plant. The frictional losses in the transmission machinery are best determined by special tests, before or after the regular run, having this one object in view.

"In a joint test of an electric railroad, made in 1891, by Hermann S. Hering and the author, they found that it was impossible to arrive at any satisfactory conclusion as to what became of the motive power generated to drive the dynamos, when throwing the load on and off again as quickly as it is done in an electrical railroad. At times there would be as much as 40 horse-power unaccounted for; that is for a few seconds the dynamo output would fall more than 80 horse-power below the then delivered turbine horse-power; while at other times the horse-power delivered by the turbines and the dynamos would be equal. The maximum difference so observed was 140 horse-power, or almost 100 horse-power in excess of that lost in the transmission machinery and dynamo.

"We are greatly surprised to find that the tests of Messrs. Spike and Hugo on the Corliss engines of the Minneapolis and St. Paul electric railway plants do show up much the same as in our tests referred to. They even note that, when lightly loaded, the difference between the engine and dynamo output is minus, showing that the dynamos are delivering more power than the engine, similar to the case we have cited for the turbine plant. We think it is due almost entirely to the fly-wheel action of the transmission machinery. We took the ground that a steam engine ought to be able to regulate itself more quickly and closely than a turbine on account of the elastic nature of the working fluid."

Then follows a most interesting series of diagrams, showing differences between mechanical and electric horse-powers in what is referred to as "Minneapolis test No. 1." Another diagram shows a plot of a variation of losses from turbine shaft to dynamo terminals as determined by a test of the turbine power plant of the "Neversink Mt. Electric Railway," Reading, Pa., under light load, and another of the same

plant under heavy load. In each of these tests "marked peculiarities in the variations of the power losses between the turbine and dynamo output are noted." A diagram of curves of power distribution from hydraulic horse-power to car axle horse-power is then given, and the various tables already mentioned follow with summaries of power distribution, efficiency and other valuable data. The topics of power losses in a cable plant and of power losses in transmitting through a countershaft, as shown in special tests made for their determination are also discussed.

Cogging a Mortise Gear.

"A pair of cut steel gears," writes Mr. James F. Hobart, in the *American Machinist*, "well designed and made, will work smoothly and almost noiselessly together, and theoretically indicate perfection in mechanical movement; but in right-down hard every-day practice, a cut pinion, working into a cut mortise gear filled with wooden cogs, leaves nothing to be desired." Mr. Hobart, who always writes ably upon mechanical subjects, goes on to say that "such perfection is seldom met with in mortise gears, or in their pinions. However, if the pinion is first-class a very close approximation to the cut mortise gear is within the reach of every mill man."

By "cut gears" it is understood that the teeth of the gear have either been cut from the solid, or dressed up after casting, by means of a milling cutter in a gear cutting machine. Not only can iron, steel, brass and wooden cogs be dressed in the gear cutting machine, but rawhide cogs would work well; but they are expensive, and when it is decided to use rawhide and metal, for the cogs of a pair of gears, it is usual to cast, and perhaps cut, the gear teeth, then make the pinion of rawhide. The smaller piece is then composed of the more expensive material.

The owners of mortise gears usually buy cogs fully machined all ready to drive and key into the gear. This method is a quick and cheap one, and a gear can be fixed up very quick by using it. But a gear thus filled does not always wear well.

The author then proceeds to say that defects do not arise from difficulty in getting good machined cogs, as these are easily obtainable; but they begin to come in through the process of setting cores while molding mortise gears in the foundry. He then, by means of drawings, illustrates defects arising from imperfect setting of cores, and their remedies, advising that only cogs having blank teeth to be finished after their insertion into the gear be used.

Other imperfections come in during the keying of the teeth in the mortises. The remainder of the article deals with this keying and all the subsequent operations necessary to finish the cogs. This part of the article is fully illustrated by drawings, and the entire article is full of sound and valuable information upon an important subject in machine construction.

THE use of typewriting machines has become so well-nigh universal, that anything written about them has the same kind of popular interest as attaches to articles dealing with home life or household affairs. Many will thus be attracted to the article printed in *Machinery* (London). The article gives not a very exhaustive résumé of the history of type-writing machines. So far as this goes, however, it is good both as to its facts and style, but after this introduction the article degenerates into a bald write-up, evidently prepared in the interest of a prominent manufacturing concern. The illustrations (?) printed with the text, are chiefly a picture of the inventor of the machine manufactured by the house so advertised at the reader's expense of time and patience, with store fronts of buildings occupied by them in New York city, and in Europe; in which the business signs over the doors are the most conspicuous, interesting, and instructive features. It seems a pity that good meat should thus be spoiled in the cooking. The history of typewriting machines, the principles of their action, and details of their construction could be made very interesting by a skillful, competent and unbiased writer.

"TESTING Indicator Springs" is the title of an article printed in *The Boston Journal of Commerce*, in which defects of

the present methods of testing springs are indicated and other methods suggested. It is believed that hydraulic pressure is not suited to testing indicator springs for the reason that it does not heat the indicator, which, in its normal working as applied to steam cylinders is always heated. Moreover, the leakage is held to prevent the successful handling of the water pressure. Steam is, therefore, considered necessary, but the measurement of the pressure by a steam gage the author believes not to be accurate, because unless steam gages are of better quality than is usual they will probably indicate more error than the springs to be tested. The article is well worthy the consideration of mechanical engineers. The author believes that all pressure should be measured by the mercury column. He gives the cost of the necessary apparatus as being about $15. The height of a mercury column indicating one pound being very nearly two inches, it is seen that pressures can be read by it to one-twentieth of a pound with sufficient accuracy for testing indicator springs. Of course the temperature must be taken into account and allowance made for change of density due to this cause. The entire article is full of information relating to indicators which those who use these instruments ought to possess. The effect upon indications of even slight friction of the pistons of indicators is thought not to materially affect the accuracy of the usual card, but when excessive it may be much misleading.

MR. FRED H. COLVIN has given some wholesome counsel on shop management in *American Machinist* of Aug. 16. He finds it difficult, however, to establish rules that will fit all cases, in this respect sharing an embarrassment experienced by all who have written upon the subject. The question of the proper relation between superintendents and workmen is considered, and the writer takes the indisputable ground that lack of harmony between them is positively costly to proprietors, as well as disagreeable all around. The writer believes that, "in the great majority of cases there is no excuse for the superintendent dealing with any one but his foremen, and when this is done the efficiency of the shop will be at its best if general plans are laid right."

INDEX TO LEADING ARTICLES.

The Machine Shop.

*24201. Modern American Machine Tools. Oberlin Smith (E Mag–Oct.) 3000 w.

24356. Economical Shop Management. Fred H. Colvin (A M–Aug. 16.) 1800 w.

24358. The Evolution of Handicraft. Ill. (Sc A–Aug. 18.) 2200 w.

24395. Machine for Testing Lubricating Oils. Ill. (S V–Aug. 15.) 1000 w.

24397. Power Losses in Transmission Machinery. (Abstract.) William S. Aldrich (S V–Aug. 15.) 1800 w.

24521. Cogging a Mortise Gear. Ill. James F. Hobart (A M–Aug. 23.) 1800 w.

*24549. Modern Typesetting Machinery. Ill. (M–Aug. 15.) 2400 w.

*24550. Typewriting Machines.—Development Traced in Europe and America.—The Yost Machine Illustrated and Described (M–Aug. 15.) 5000 w.

*24628. How to Splice a Wire Rope. Ill. (Mill–Aug.) 450 w.

24669. Intelligence Conveyed by Drawings. B. F. Spalding (A M–Aug. 30.) 3300 w.

24670. Accurate Hole Locating. Ill. Oberlin Smith (A M–Aug. 30.) 1800 w.

†24883. The Evolution of the Workshop. C. John Hexamer (J F I–Sept.) 4800 w.

Steam Engineering.

*24203. Development of the Steam Engine Governor. Ill. Henry G. Conant (E Mag–Oct.) 3000 w.

24269. Testing Indicator Springs (B J C–Aug. 11.) 1800 w.

24290. Some Experiments on the Effect of Water Hammer. R. C. Carpenter (E R–Aug. 11.) 2400 w.

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24396. The Boiler Inspection Laws of Great Britain (S V–Aug. 15.) 2500 w.

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*24537. Engine Cylinders. Ill. (M W–Aug. 17.) 2500 w.

*24572. The Most Economical Temperature for Steam Engine Cylinders; or, Hot v. Cold Walls. Bryan Donkin (C G–Aug. 17.) 1100 w.

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24590. Steam Elevators. How Their Direction of Motion is Reversed. Ill. (B J C-Aug. 25.) 600 w.

24592. Boiler Testing. The Measurement of the Water (B J C-Aug. 25.) 1300 w.

*24607. The Hunting of Governed Engines. James Swinburne (E E L-Aug. 17.) 2000 w.

24630. Application of Fuel Oil to Steam Generators. Clayton O. Billow (E E-Sept.) 5500 w.

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24632. The Prevention of Smoke. John C. McMynn (E E-Sept.) 300 w.

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24739. Finding Moisture in Steam —How a Noted English Engineer Does It (B J C-Sept. 1.) 1000 w.

24740. Compression in Steam Engines.—Too High Compression Not Advisable (B J C-Sept. 1.) 900 w.

*24795. The Economical Efficiency of Locomotives as Compared with Stationary and Marine Engines (A E R J-Sept.) 5800 w.

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24820. Direct and Indirect Connections to Indicators. Ill. (Pr-Sept.) 1800 w.

24821. The Relation of Steam Space and Horse-Power of Boilers. Stephen Quentin Hayes (Pr-Sept.) 1800 w.

24822. Steam Pipe Covering. Ill. Walter Meyer Dickinson (Pr-Sept.) 900 w.

24858. Steam Power in Mills. W. H. Booth (A M-Sept. 6.) 1500 w.

†24882. The Graphics of the Efficiencies of the Steam Boiler. R. H. Thurston (J F I-Sept.) 2700 w.

Serials.

13033. Practical Hints to Boiler-makers and Templaters. Ill. (M W-Began May 12, 1893 —12 parts to date—30 cts. each).

18986. Boiler Calculations. James F. Hobart (S M—Began Jan. 15—Ended Aug. 15—10 parts—15 cts. each).

19709. The Indicator and Its Diagrams. Charles Day (P Eng-Began Feb. 2—16 parts to date—30 cts. each).

20182. The Elements of Boiler-Making. Ill. C. E. Fourness (L E-Began March—7 parts to date—30 cts. each).

21141. High Speed Steam Engines. Ill. John Radinger (E M-Began April—6 parts to date—30 cts. each).

23826. Comparison of Different Formulæ for Dimensions of Parts of Steam Engines. William Kent (A M-Began July 26—3 parts to date—15 cts. each).

24129. The New "Porter" Steam Engine. Ill. (M W-Began July 27—Ended Aug. 3—2 parts—30 cts. each).

24299. The Strength of Thick Cylinders. Ill. W. C. Popplewell (P Eng-Began Aug. 3—Ended Aug. 17—2 parts—30 cts. each).

24722. Methods of Determining the Dryness of Steam—Report of Committee. W. C. Unwin, Secretary (Eng L-Began Aug. 24—2 parts to date—30 cts. each).

24930. Some Notes for Enginemen and Firemen. W. H. Booth (E L-Began Aug. 31 —1 part to date—30 cts).

Miscellany.

*24205. Management of Men in Mills and Factories. W. H. Wakeman (E Mag-Oct.) 3000 w.

*24426. Description of Twin-Screw Propellers with Adjustable Immersion Fitted on Canal Boats. Henry Bancroft (Eng L-Aug. 10.) 2000 w.

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*24599. The Apprentice System (I C B-Aug. 17.) 1600 w.

*24602. A Warning to Workmen.—Regarding Health (I C B-Aug. 17.) 1500 w.

*24694. The Pneumatic Pyrometer. Ill. Henry Morton (E-Aug. 24.) 2500 w.

*24696. The Critical Side of Mechanical Training. Editorial (E-Aug. 24.) 2800 w.

*24766. The Position of Patent Agents: Collapse of the Bills and Reverses of the Chartered Institute (Inv-Aug. 25.) 3700 w.

*24768. The Decay of Workmanship (I C B-Aug. 24.) 1400 w.

24836.—$1.25. Air Pumps. Ill. F. H. Bailey (J A N E-Aug.) 11000 w.

24846. The McMyler Machine for Coaling Lake Steamers. Ill. (Ir Age-Sept. 6.) 1200 w.

24859. Standard Pulley Hubs and Cores. Ill. Walter B. Snow (A M-Sept. 6.) 1600 w.

*24925. The Production of Compressed Air in Paris. Ill. (I & I-Aug. 31.) 1500 w.

Serials.

17900. Machine Shop Milling Practice. Ill. Horace L. Arnold (A M-Began Dec. 7—12 parts to date—15 cts. each).

18044. Motive Power and Gearing. E. Tremlett Carter (El-Began Dec. 1—21 parts to date—30 cts. each).

19638. Blowing Engines and Machinery. Albrecht von Ihering (E M-Began Feb.—7 parts to date—30 cts. each).

20171. Practical Notes on Rope-Driving. M. E. (S R J-Began March—4 parts to date—45 cts. each).

20900. Mechanical Drawing. Ill. (T-Began April 1—7 parts to date—15 cts. each).

23937. Some Practical Hints in Dynamo Design. Gilbert Wilkes (S R G-Began July 28 —Ended Aug. 25—3 parts—15 cts. each).

24038. Compressed Air.—The Problem of Transmitting Power to Long Distances by Its Use. Ill. (C E-Began Aug.—2 parts to date—30 cts. each).

24173. The German Patent System. Gustav Bissing (E R N Y-Began Aug. 8—Ended Aug. 22—3 parts—15 cts. each).

We supply copies of these articles. See introductory.

MINING & METALLURGY

Modern Concentrating Mills.

UNDER existing conditions no branch of metallurgy is of more interest or more pressing importance than that of concentration. This applies more particularly to the mining regions of the western United States, to those of the Spanish-American countries, and to newly opened districts in various parts of the world. In Europe, and especially in Germany, the importance of the subject has long been recognized, and systems of concentration developed to a degree of perfection not attainable where the circumstances are less favorable as to labor and other costs, unless by the substitution of the most advanced mechanical appliances for hand-work in certain departments.

A timely series of editorial articles on ore-concentration have lately appeared in the London *Mining Journal*, in which practical applications, rather than mere generalizations, have been considered. The *Journal* records the fact that few mills of the modern type have been erected in the British isles, while German manufacturers have almost a monopoly for work of this sort, and says that it would appear that English and Welsh makers have paid but little attention to the science and art of concentration, having contented themselves with following in the rut beaten out by their predecessors in the early part of the century. It therefore looks for examples of the most perfect forms of modern concentrating mills to those erected by continental firms. Reference might here be made to the very efficient and economical mills of the Lake Superior copper region; but, as the treatment of ores containing but a single mineral (as pyrite carrying gold, galena, copper or zinc) is comparatively simple, the *Journal* devotes attention mainly to the more difficult mixed ores in which the difference in specific gravity between the various valuable minerals and the gangue is so slight as to call forth the utmost skill on the part of the designer of the mill. There are however certain ores containing single minerals—notably the tellurides and chlorides—which on account of a tendency to sliming because of friability and fine dissemination, present problems even more difficult than do the ores of mixed heavy sulphides; and just now the great demand in the western states is for means of successfully treating this class. However, the general type of mill described by the *Mining Journal* is that adopted in standard practice. Such a mill is usually placed upon a hillside, to take advantage of the natural slope of the ground for the automatic conveyance of the mineral downward from one machine to the next, for which purpose the ground is cut into terraces, on the upper of which the main crushing and hand-picking appliances are placed, on the middle the jigs and fine crushers, and on the lower the slime-dressing machinery. In the opinion of the *Journal* this is by far the most suitable and economical plan. If however the country is flat and the differences of level cannot be obtained except by constructing a high mill, then the only alternative is to use elevators. In mining regions, which are usually mountainous, or at least hilly, sites offering convenient natural grades are generally obtainable, and the common practice has been to take advantage of them, comparatively little grading being required. Yet latterly a difference of opinion as to mill-sites has arisen, and here the *Journal* falls foul of the Denver group of engineers who have abandoned the old system of building a mill in terraces, and prefer to build it on the flat. Their argument is that with improved elevators the cost of maintenance of a flat mill is less than the interest of the money spent in the construction of terraces and that a more compact and convenient ar-

rangement is possible in the flat mill. The *Mining Journal* contends that it is cheaper and handier to allow the stream of crushed ore to run, as a stream of water, down hill through the various machines, than to be constantly elevating it to gain the necessary head. In this it is supported by the best former practice; yet there is much to be said on the other side, while unquestionably the expense of elevating has been so cut down that it is not the bugbear that it has been.

Whichever plan is adopted, the sequence of the machines is the same. Following the *Journal's* description of a typical mill, the ore as it comes from the mine is tipped over grizzlies, and then passes to the rock-breakers. The type of breaker to be employed, as well as the whole system of crushing and classification, it is pointed out, depends upon the size of the mineral grains in the ore, and the *Journal* rightly remarks that the crushing should be conducted with a view to liberating these grains or crystals from the gangue without pulverizing, so as to avoid the formation of slimes as much as possible. This is the recognized principle of successive crushings. From the breaker the ore passes through a coarse sorting trommel, which removes the fine gravel and sand and at the same time washes the large pieces clean for hand-picking. Of the two kinds of hand-picking tables, the longitudinal belt is advocated in preference to the rotating table, as giving more room for the pickers, and consequently a closer sorting. All the ore which has passed through the grizzly, as well as that delivered at the end of the sorting-table, then passes together to the main rolls; which differ from the old form in that they are of larger diameter, revolve quicker, and have rubber buffers instead of weighted levers, as safeties against breakage. The next stage, that of classification by size, is a critical one, and, as the *Journal* observes, here the skill of the specialist is brought into play to determine the number and size of the grades into which the ore is to be divided, the sizes and degree of classification necessarily differing with the variety of mineral treated, its friability, and distribution in the gangue. The question has received much attention at the German metallurgical works, where classification is carried much further than in American mills, many of which crush fine at once, and rely on a single system of concentration. Coarse classification is effected by means of trommels and the fine by hydraulic classifiers. The ore from the trommels goes to the jigs, of which there are one or more for each size produced. These are the standard machines for coarse concentration, although, as the *Mining Journal* remarks, now that they have been improved they are employed fairly within the limits of fine concentration. The product of the jigs is in the form of rich concentrates, middlings and steriles. The first are removed to the bins to await shipment, the last are thrown away, and the middlings are reground by separate rolls. It is to be noted that the old tailings or waste dumps of abandoned works, payable if concentrated with modern appliances, are in the condition of the middlings from the jigs, and from this point their treatment should be similar, starting with the re-crushing machinery.

As the ore becomes finer, the difficulties of concentration increase, and with these difficulties comes increased loss. Since in American gold mills which concentrate after amalgamation the ore is finely crushed (by stamps, not rolls) at the outset, only fine concentration is possible, with its difficulties and losses. Although such mills, equipped with bumping tables and belt vanners, do tolerable work, they are constructed on wrong theoretical lines so far as concentration is concerned; and though the *Mining Journal* does not advert to such cases, its general conclusions are entirely pertinent: "Every effort should in the first place be made to avoid crushing the ore beyond the point at which it will separate from the gangue. If this is not done, and the ore is indiscriminately reduced to powder, the amount of slimes to be concentrated will of course be great, and the loss in concentration equally great. With some ores fine crushing is unavoidable, owing to the mineral being finely dispersed through the gangue. The mod-

ern mill manager, however, should so design his mill that the ore is crushed gradually, the rich product being extracted between the crushings, and not, as is too often the case, smashed to powder, and sent on with the slimes to the fine concentrating department." This principle is well understood, but too seldom acted upon, and cannot be too often enunciated.

Pebble Phosphates of Florida.

PEBBLE-PHOSPHATE mining is comparatively a new industry in Florida, having begun so recently as 1890. Mr. Perry M. DeLeon communicates to the *Manufacturers' Record* a comprehensive account of the experience and present condition of the companies operating the pebble deposits, with a description of the mode of occurrence of the latter, from which the following notes are derived. "Land pebble," as its name implies, is a phosphatic pebble varying in size from a pin's head to a hickory nut, most of it being about the size of a pea, although some of it is as large as a walnut; and, as is generally the case, the fine phosphate is higher in grade and freer from iron and alumina. Its color is from a creamy white to a dark brown. It is supposed to occur in drift deposits washed down from the boulder-phosphate region. The average overburden in those mines which have been worked is from four to five feet, but the phosphate is found at varying depths, from an outcrop to many feet underground. The beds are nearly horizontal and vary in thickness from one to twenty feet, averaging about ten feet. Unlike the boulder deposits, the pebble-phosphate beds are continuous over large areas, so that prospecting by sinking pits is simple, and much of the uncertainty of phosphate mining is eliminated. The percentage of clean, washed and dried phosphate to the whole mass of the deposit may be from 20 per cent. to 30 per cent., the phosphate weighing 80 to 90 pounds per cubit foot. The grade varies from 65 per cent. to 70 per cent. of bone phosphate of lime, and the average is stated as fairly 68 per cent. The overburden also varies, consisting of sand or clay in some places and iron conglomerate or sandstone in others.

The land-pebble mines thus far developed are all in Polk county, although excellent deposits are known to exist in the counties to the west and south. The requisites for successful mining are quality, quantity, water and transportation. At present there are ten companies actually mining, three not mining, and two which are erecting plants, while other enterprises are projected. The net commercial results thus far, according to Mr. DeLeon's account, have hardly been satisfactory, large sums having been wasted, and in some cases heavy debts incurred by the companies in the past experimental stage of the industry. This, however, is not considered necessarily discouraging by our authority, who reminds us that all new enterprises have to go through a crucial period, and states that nearly all of the active companies have well-equipped plants and are now mining successfully. The Carolina companies went through a far more trying experience, in some cases occupying five years in solving the problems presented and getting their business on a profitable basis.

Mining is conducted by the hydraulic process, the low, level land being flooded. An hydraulic plant consists of a boat on which are an engine, boiler, force-pump, centrifugal or suction pump, rotary or flat screen, and washer. The force-pump washes the material into a sump, from which it is sucked up by the centrifugal pump and delivered upon the screen, from which it passes to the washer and is discharged into a lighter alongside. The lighter is then poled to the wet bin and the phosphate carried by elevators to the rotary drier and thence again elevated to the dry bin of the mill, where it awaits shipment. This is the usual method. One company uses a dipper dredge, while two companies use steam shovels and convey the material by trams to their washers, and one company employs a grappling dredge; but the pumping method is considered by Mr. DeLeon to be the best, steam shovels being applicable only under exceptional conditions. Early failures are

ascribed to inefficient equipment, which defect has been remedied by the introduction of more powerful plant.

Good phosphate land, where the conditions already mentioned are favorable, sells for $50 to $75 per acre; lands remote from transportation cheaper. A plant of machinery costs about $50,000, and in all at least $75,000 to $100,000 is necessary to start a mine capable of producing from 20,000 to 40,000 tons yearly. The plants being put up are designed by experienced experts, and their management will be more economical. The outlook is reported as promising.

The Emery Deposits of Naxos.

NAXOS is remarkable as being one of the few localities producing emery on a large scale, and while the corundum mines of the United States yield an even more valuable product, large quantities of the Naxos mineral are annually imported for use in the various arts. Mr. A. Gobautz has lately presented a monograph on the emery deposits of the island, which appears in the foreign abstracts of the Institution of Civil Engineers and is reprinted in the *Colliery Guardian*. The author describes the deposits as of irregularly bedded or lenticular form, being concentrated on the mountains at the northern end of the island. The masses of emery are very variable in size, ranging in length from a few feet to upwards of 100 yards, with a maximum thickness of from 5 to 50 yards. They are closely associated with limestone beds, and lie at all degrees of slope from horizontal to nearly vertical. Seventeen different deposits have been found and worked. The largest working covers an area of more than 30,000 square meters, extending for more than 500 meters in length with a maximum thickness of 50 meters. The highest quality of mineral is taken from two comparatively thin but extensive deposits, in stratified bands. Mineralogically, emery is a compact mixture of blue corundum and magnetic iron ore, its value increasing with the proportion of the former constituent. The average composition is about ⅔ corundum, ¼ magnetite, ⅛ silica, with some carbonate of lime, while inferior samples have been found to contain as much as 60 per cent. to 66 per cent. alumina. The method of mining is described as extremely primitive. The right to mine is given to about 600 workmen, who have the privilege of working the mineral wherever and in what way they think best. The rock is broken only by fire-setting. An area 5 feet broad by about the same height is cleared from loose material, and a pile of brushwood heaped against it and lighted. After being thus heated for 24 to 30 hours, the rock is suddenly chilled by throwing water upon it, when fractures are produced, enabling the mineral to be broken down and removed. Very rarely blasting with dynamite is resorted to. There are no extensive underground workings, the method of fire-setting being applicable only at the surface. Systematic quarry working, with diamond boring machines and powerful explosives, and the use of wire ropeways and jetties for facilitating transportation, are projected; but the primitive system still obtains. The competition of the emery mines of Asia Minor has become so severe that exports of emery from Naxos have greatly fallen off. It is somewhat remarkable that a foreign company, employing the means of working the deposits by modern methods, has not obtained a concession to utilize these valuable resources on a large scale.

Electricity in Coal-Mining.

FOR some time it has been possible to claim that all the operations of mining in which power is required can be performed by the aid of electricity, added to which the same agency is applicable for lighting the underground workings and the surface plant, for signaling, and for firing the blasts. Complete installations of electric equipment are now no rarities either in American mines or those of other countries, especially where water-power is available, even if at some distance from the point of application, to which the subtle energy is readily conducted, often in positions where, from excessive altitude and the scarcity of fuel or water the use of steam is practically precluded. Such con-

ditions exist at many silver and gold mines of the United States. But there is a far wider field for electricity in mining, and latterly it has been encroaching upon steam and manual labor in regions where a fair competition is offered and comparisons can be made upon even terms. Here the conditions of economy, safety and convenience are fully met by the newly introduced force, whose use is steadily increasing. There are now many mines where electricity is practically the only power employed, for drilling, ventilating, pumping, hauling and winding, signaling, explosive-firing and lighting. As is justly remarked by *Black Diamond*, in a recent editorial article, electricity is, in fact, indissolubly bound up with mining, and especially mining for coal; and no industry has gained more practical benefit from its introduction than the coal industry.

In the article referred to it is pointed out that the old-style lamp and lantern system is archaic as well as dangerous, and that even in the safest collieries a sudden burst of pent-up gas may work irreparable harm. The advantages of the incandescent lamp are that it requires no trimming, is not affected by currents of air and is exposed in no way to contact with gas. The danger of breakage is partly provided against by having double glasses. This lamp throws a far more powerful light, thus expediting work and enabling the miner to detect loose roof or threatening coal falls in thick seams; while the best of the safety lamps give insufficient illumination the stronger arc light is valuable at the pit-head, at the screens, etc. Great improvements have been made in drills, and several electric rotary drills have been used with success. Coal-cutting machines driven by electricity have also been greatly improved, and in operating these and other underground machines sparking is obviated. The electric fan, placed at the most advantageous positions, greatly facilitates ventilation. To meet sudden influxes of water what is wanted is a pump that can be quickly got to work on the spot, which is one of the great merits of the electric pump. In French collieries the telephone is extensively used, while electric bells are employed for signaling in English and other mines. These bells can be operated from the moving cage. The simultaneous firing of blasts by electricity effects a saving of time and reduces the proportion of missed shots, thus eliminating a frequent source of danger. *Black Diamond* affirms that electricity not only renders mining healthier and safer, but really improves to a wonderful degree the productive capacity of a mine, with greater facility in handling the product. Our contemporary is not only very positive as to the undeniable advantages of an electric equipment, but sanguine as to further and rapid progress in this direction.

A Model Steel Plant.

A DETAILED account of the great steel plant of the Ohio Steel Co., now nearing completion at Youngstown, Ohio, appears in the *Iron Trade Review*. This enterprise has been brought about by the movement of the center of iron production westward from Pittsburg, the rapid cheapening of steel and its consequent displacement of iron. An appreciation of the situation by the leading iron producers of the Mahoning valley led to a discussion of the steel works project long before any tangible development of the plans or the personnel of the new organization. As the *Review* observes, a modern steel plant means a vast outlay of capital, and so rapid has been the evolution of economizing equipment that plans that have once been allowed to cool would require no little revision to adapt them to the most advanced practice when they are taken up again. The steel mill itself was designed in the latter part of 1892, work being begun early in 1893. From the time that it took shape on paper there has been a steadily increasing drift in the iron and steel markets to confirm the judgment of its promoters, who are largely interested in the local iron industry. The site includes 200 acres, the Mahoning river, which flows through the tract a few hundred feet from the main building, affording ample water supply. In the arrangement of the buildings and transportation great care has been exercised to secure rapid and economical hand-

ling of material, and the laying out of yards has been with a view to the most advantageous extension of the present plant. Indeed everything evinces a broad-gage policy and foresight for the future. A site is provided for the blast furnaces which may sometime be erected by the company; but meanwhile Bessemer pig will be bought in the market. A number of furnaces are located within a mile to a few miles of the steel plant. For an enumeration of the items of the equipment the reader must be referred to the original article (*Iron Trade Review*, August 16), but it may be said that everything is thoroughly up to date. For example, in the main boiler-house, containing four batteries, or eight boilers, each of 250 horse-power, the conveying apparatus and mechanical stokers render the whole so nearly automatic that a man and a boy can fire the whole 2000 horse power outfit. The probable output of the works is a matter that actual practice only will demonstrate, so that estimates are rather premature; but at the start 500 tons will be turned out daily, while there is no question as to increasing this in time to 1000 tons, and there are confident expectations that 1500 tons will be ultimately reached. These figures give some idea of the extent of the plant. Besides billets and slabs, sheet and tin-plate bars will be included in the product of the mill. The manufacture of steel rails is something for the future to develop, but when the times are propitious the rail-mill can readily be added. The supply of pig will call for the output of half a dozen of the average blast furnaces of the vicinity.

Gold and Coal in Victoria.

IN the last government report the Minister of Mines for Victoria is again able to report an increase in the output of gold in the colony of 16,670 ounces over the yield for 1892. This report has been ably summarized in the *Mining World*, from which abstract it appears that progressive work is being done in all parts of the colony. Attention has been turned to old gold-fields long neglected and in some cases almost forgotten, where formerly the difficulty of separating the gold from the refractory ores of the base metals proved an insurmountable obstacle that is in part removed by improved metallurgical processes. In addition to this much prospecting is being done, resulting in fresh discoveries being made from time to time. The future outlook for the gold-mining industry of Victoria is regarded as more cheerful than might have been anticipated, judging from the financial depression which has prevailed in Australia as well as in other parts of the world.

The concentration and reduction of auriferous sulphide ores, and the saving of fine gold, are problems which still confront the gold-mines of Victoria, as they have and still do in all gold-mining regions. One division of the government department of mines has been engaged in experimenting along these lines. It might be suggested that much light might be gained by studying and profiting by the experience acquired in the gold mines of the United States and of the Transvaal, where to a certain extent, though by no means wholly satisfactorily, similar problems are being worked out in practice.

The coal industry may be said to rank next in importance to gold-mining in Victoria. The known area of workable coal has been much extended by boring. The actual product is not yet very large, but the reports are highly encouraging. The further development of this industry, it is hoped, will provide work and subsistence for many of the men now unemployed.

Valuation of Mines.

ON this much-debated and still far from settled question the *Mining and Scientific Press* has something to say in a late issue. After adverting to the influences which lead investors to enter into mining ventures in out-of-the-way regions where the natural conditions are adverse, rather than to buy mining ground in older localities where climate, resources and facility for obtaining machinery are superior, the *Press* comes to the essential points—the difficulty of establishing a standard of value and of getting seller and buyer to

look upon the transaction in the same light. That journal says:

Most things for sale are worth what they will bring. It is different with a mining claim. Sometimes it is worth less than the purchase money; oftentimes more. But, in the case of buying and selling mining property, that is a matter that ordinarily must be determined after the transfer is made. A man may pay $10,000 for a piece of mining property that will show itself worth $1,000,000 after he has spent a few thousand additional dollars on it, or it may not be worth the amount annually necessary to expend in order to hold it. . . . The same general site, appearance and showing that made one claim worth a million will not hold good in the one adjoining it.

There is undoubtedly a large element of uncertainty as to the value of undeveloped and partially developed mining ground, and this is especially true of mines of the precious metals; yet our contemporary's statement of the case is rather extreme. A mine that has been carefully examined and thoroughly sampled will show very plainly what is in it so far as the development permits investigation. There is always risk, and on the other hand there are occasional "flukes" of unexpected good luck; yet it is not all blind guesswork.

Again, it is possible to estimate in advance with tolerable accuracy what the cost of equipment and for a certain amount of development will be. The seller is often in the position of holding ground which he is unable to work profitably, from lack of means to put in the necessary plant to operate on a large enough scale, and here the advice of the *Mining Press* to holders, to "think twice before a reasonable offer is refused," is quite pertinent. The only trouble is to get both parties to the transaction to agree as to what is "a reasonable offer."

Steel Manufacture in the South.

AFTER long discussion and considerable experimenting, steel-making in the Southern states remains a vexed question, which is treated by Mr. C. A. Meissner, in a very practical and conservative manner in the *Iron Age*. Mr. Meissner considers that Bessemer steel will probably never be made from exclusively Southern ores, as none of them are true Bessemer ores except those of the Cranberry district, North Carolina; and that it is doubtful whether the concentration and phosphorus-elimination of other Southern ores could be done with sufficient economy. There is a proposition to bring Cuban ore to Mobile or Pensacola, there to meet coke from Birmingham, Alabama, with limestone flux near-by, and to erect a Bessemer steel plant to supply the Southern, Southwestern and Central and Southern American markets. The costs of making steel in this way at a gulf port, and the probable market, are analyzed by Mr. Meissner, who is not very sanguine of success until the Nicaragua canal has been built, to open west-coast markets. Turning to the manufacture of basic steel, the author gives the history and the technical and commercial results of the small plants already built, and states that enough has been done to indicate that the process is perfectly feasible. Past failures are ascribed to want of good technical and economical management and to a too keen desire for experimenting with untried methods. As he tersely puts it, "money can build a plant, yet it cannot run it, unless combined with the highest scientific skill"—and this is especially demanded in the basic process and its modifications. Some very fine steel has been made by the existing plants, whose experience is described in detail, with results of tests and analyses of materials and product. The substitution of dolomite for magnesite as a dephosphorizer is reported to have effected a considerable saving in expenses.

INDEX TO LEADING ARTICLES.

Metallurgy.

24346. The Hawdon Slag Machine. Ill. (Ir Age-Aug. 16.) 2000 w.

24347. The New Tariff in the Iron and Metal Trades. Editorial (Ir Age-Aug. 16) 1600 w.

24348. Our Exports of Metals, Machinery

We supply copies of these articles. See introductory

and Hardware. Editorial (Ir Age–Aug. 16.) 1200 w.

24349. A Comparison of the Old and the New Rates of Duty (Ir Age–Aug. 16.) Table.

24354. Notes on Foundry Management. S. Bolland (A M–Aug. 16.) 2000 w.

†24377. Fire Assay for Lead. Malvern W. Iles (S M Q–July.) 3000 w.

24407. Molding Condensors. Ill. (F D–Aug.) 1200 w.

24413. Consumption of Iron in Japan. T. Wade (E M J–Aug. 18.) 700 w.

*24455. Modern Concentrating Mills. Editorial. (M J–Aug. 11.) 2000 w.

24466. A Modern Steel Plant. Ill.—Ohio Steel Company's Mills, Youngstown, Ohio (I T R–Aug. 16.) 2600 w.

24467. The Metal Schedule-Provisions of the Senate Tariff Bill as Finally Passed (I T R–Aug. 16.) 2500 w.

24504. Steel Manufacture in the South. C. A. Meissner (Ir Age–Aug. 23.) 2000 w.

24516. Alloys. J. T. Hewitt (Sc A S–Aug. 25.) 2200 w.

24538. Scandinavia as a Source of Iron Ore Supply. (Abstract.) Jeremiah Head (E M J–Aug. 25.) 2600 w.

*24557. The Separation of Titanium or Rutile Ore. Walter J. May (Inv–Aug. 18.) 1600 w.

*24571. Disintegrating Iron Ore Prior to Concentration. Walter J. May (C G–Aug. 17.) 1000 w.

24597. Is Metallic Titanium in Bulk Probable? Walter J. May (A M & I W–Aug. 24.) 1000 w.

*24604. The Iron and Steel Industries of Belgium (I C T–Aug. 17.) 2000 w.

*24626. Modern Concentrating Mills. Editorial. (M J–Aug. 18.) 1800 w.

24651. Manufacture of Spiegeleisen. Ill. (Sc A–Sept. 1.) 1000 w.

24664. The Armor Plate Report (Ir Age–Aug. 30.) 2500 w.

24671. Plans and Methods Necessary for Obtaining Comparative Physical Tests of Cast-Iron. Ill. Thomas D. West (A M–Aug. 30.) 6700 w.

24683. Punching as a Means of Testing Structural Steel. T. L. Condron (R G–Aug. 31.) 2400 w.

24719. On the Use of Caustic Lime in the Blast Furnace. Lowthian Bell (I & S–Aug. 25.) 4800 w.

*24721. On the Influence of Aluminum Upon the Carbon in Ferro-Carbon Alloys. T. W. Hogg (Eng L–Aug. 24.) 1600 w.

*24765. The Manufacture of Steel in the Open Hearth. James Alexander Lencauchez, with Discussion (I C T–Aug. 24.) 5000 w.

*24784. Examples of Modern Concentrating Mills (M J–Aug. 25.) 2500 w.

24844. Coking with Recovery of By-Products. Ill. (Ir Age–Sept. 6.) 4800 w.

24845. Forging by Hydraulic Pressure. (Extract.) Ill. Ralph Hart Tweddell (Ir Age–Sept. 6.) 4200 w.

24847. Rolling and Re-rolling of Iron Rails. W. F. Durfee (B I S–Sept. 5.) 2000 w.

24860. Making a Drum in Loam. Ill. J. Horner (A M–Sept. 6.) 2000 w.

*24916. The Value per Metallic Unit in Proportion to Cost of Iron Ores. Walter J. May (C G–Aug. 31.) 1000 w.

Serials.

21369. Press Working of Sheet Metals. Ill. Oberlin Smith (Ir Age–Began April 19—5 parts to date—15 cts. each).

21814. Plate Moulding. Ill. J. Horner (P Eng.–Began April 27—7 parts to date—30 cts. each).

22710. Science for Iron-mongers. Ill. (Irm –Began June 2—8 parts to date—30 cts. each).

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24856. Recent Improvements in Gold Chlorination. John E. Rothwell (A M S–Began July 28—1 part to date—30 cts).

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*24200. A Review of American Mining Law. W. C. Wynkoop (E Mag–Oct.) 3000 w.

24216. Gold Mines Around Charlotte, N. C. F. Powell (M R–Aug. 10.) 1300 w.

24217. Pebble Phosphates of Florida. Perry M. De Leon (M R–Aug. 10.) 2100 w.

†24225. The Slate Quarries of Wales. (I E–July 7). 1500 w.

*24233. The "Home" of Gold. Editorial (M J–Aug. 4.) 1000 w.

*24260. Iron Ore Formations. Ill. (C G–Aug. 3.) 2800 w.

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24363. Valuation of Mines. Editorial (M S P–Aug. 11.) 1000 w.

†24379. The Kosaka Mining and Reduction Works, Ricchoo, Japan. Ill. M. Kuwabara (S M Q–July) 5000 w.

24389. Australian Emeralds. John Plummer Min R–Aug. 2.) 500 w.

*24408. Gold in Victoria (Min W–Aug. 11.) 1300 w.

*24409. Coal in Victoria (Min W–Aug. 11.) 1100 w.

*24429. Electricity in Mines. W. E. Lishman (C G–Aug. 10.) 4000 w.

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*24430. The Emery Deposits of Naxos. A. Gobautz (C G-Aug. 10.) 800 w.

*24456. First Impressions of the Murchison Gold Fields. W. G. Gibson (M J-Aug. 11.) 1500 w.

*24570. Mines under the Sea-shore and Seabed (C G-Aug. 17) 2200 w.

*24573. The Probable Range of the Coal Measures under the Newer Rocks of Oxfordshire and the Adjoining Counties. Boyd Dawkins (C G-Aug. 17.) 1400 w.

*24574. The Screening of Coal. Ill. Robert Edden Commons (C G-Aug. 17.) 4600 w.

24596. Mine Ventilation. Suggestions of W. Humble (A M & I W-Aug. 24.) 900 w.

*24625. Resources of the Thames Gold Field (M J-Aug. 18.) 1400 w.

*24627. Cyanide and Gold Mining. Editorial (M J-Aug. 18.) 900 w.

24639. An Interesting Mine Installation (E R N Y-Aug. 29.) 850 w.

24645. A Visit to the Slate Quarries of Angers. Ill. (Sc A S-Sept. 1.) 2300 w.

24654. The Origin of the Gold of Quartz Veins. J. Logan Lobley (M S P-Aug. 25.) 2100 w.

24655. A Vast Copper Mine (M S P-Aug. 25.) 800 w.

*24693. An Antidote for After-Damp (C T J -Aug. 25.) 1200 w.

*24698. On the Non-Correlation of the Dover Coalfield with Other English and French Fields. Ludovic Breton (C G-Aug. 24.) 800 w.

*24699. The Coal Mining Industry of Belgium. M. A. Briart (C G-Aug. 24.) 7800 w.

*24700. Suffocation in Mines. Summary of paper by J. S. Haldane (C G-Aug. 24.) 1200 w.

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24727. The Magnetization of Iron Ores. William B. Phillips (E M J-Sept. 1.) 1100 w.

*24803. Zinc Mining.—Methods of Working the Zinc Deposits near Webb City, Mo. Ill. O. Rees (C E-Sept.) 900 w.

24832. Gold Mining in Alabama. W. M. Brewer (T-Sept. 1.) 3000 w.

24863. Copper Mining in Cape Breton (C M R-Aug.) 1400 w.

24864. The Sydney Coalfield. Ill. Hugh Fletcher (C M R-Aug.) 3000 w.

24865. The Introduction of Endless Haulage into Cape Breton. W. Blakemore (C M R-Aug.) 1600 w.

24866. Gold Mining in Nova Scotia.—A Review of Operations in the Various Localities. John Rutherford, with Discussion (C M R-Aug.) 3500 w.

24867. Silver Mines of West Kootenay, B. C. E. D. Ingall (C M R-Aug.) 2500 w.

†24886. Drilling for Oil and Natural Gas in the Vicinity of Philadelphia. Oscar C. S. Carter (J F I-Sept.) 2200 w.

*24919. Iron Ores of the Mediterranean Seaboard. (Abstract.) A. P. Wilson (Eng L-Aug. 31.) 1100 w.

*24920. The Part of Coal Dust in Mine Explosions. Editorial (Eng L-Aug. 31.) 2200 w.

*24928. Mining Fallacies. Editorial (M J-Sept. 1.) 1500 w.

Serials.

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20414. Geology of Coal. Ill. (C E-Began March—7 parts to date—30 cts. each).

20415. Mining Machinery. Ill. (C E-Began March—7 parts to date—30 cts. each).

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24152. Notes on the Philippine Islands. Frank Karuth (M J-Began July 28—6 parts to date—30 cts. each).

24259. The Coal Dust Theory of Explosions (C G-Began Aug. 3—2 parts to date—30 cts. each).

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24918. The French Northern and Belgian Coalfield. Ill. Marcel Bertrand (C G-Began Aug. 31—1 part to date—30 cts).

MUNICIPAL ENGINEERING

The Waste of Cities.

IT IS estimated that at the end of the first quarter of the present century only about 5 per cent. of the population of the United States lived in cities. Now, according to a leading editorial in the *Progressive Age* our intramural population reaches 33 per cent. of the total population. With increase of population has come an increase of the waste constantly going on in our cities. This waste consists largely of fertilizing material flowing out through sewers, which annually amounts to millions of dollars. The editorial, however, does not deal with this waste, but with that pertaining to garbage. The subject is considered with reference to three aspects. The first has relation to the expense of the disposal of such refuse as is usually classed as garbage. The second is the effect upon sanitation of present methods, and the third is the economic question of saving the fertilizing materials which city garbage contains. With reference to methods now in use, and the sanitary aspect of the subject, the article says:

From reasonable acquaintance with most of the important cities of the country we fail to remember one that has thus far succeeded in disposing of garbage to the entire satisfaction of its population. Several of the prominent cities it is true have expended large sums of money in laudable attempts to solve the problem, but with few exceptions, the means adopted have not met the expectations of the promoters. Some cities derive a revenue from the sale of offal to farmers, the latter using the product mainly to feed pigs, others having salt water advantages, as New York, carry the refuse out to sea, where it is dumped to await the action of tides and winds in carrying the major portion back to neighboring shores, to the injury and annoyance of adjacent dwellers. Open carts are almost invariably employed in the collection of garbage and ashes, and when one of these carry-alls passes through our streets, Gabriel's trumpet is not needed to herald its approach. These transports are in themselves a direct menace to health. The Massachusetts Board of Health has devoted serious attention to the garbage question during the past few years, and in a recent report issued by that body, it is stated that the Boston offal disposed of to farmers and used for the food of swine shows that over 12 per cent. of the hogs within a radius of thirty miles of that city, and 17 per cent. of those kept at public institutions, were infested with trichinosis. Furthermore, the investigations of this board show that the admixture of city swill with the feed of cows increase the alarming death-rate of bottle-fed infants in the tenement sections of Boston.

In Boston, early in 1893, a committee was appointed to consider the question of disposal of garbage. The committee was instructed to investigate first, the destruction of garbage by incineration; second, its disposal by chemical treatment, thereby saving its valuable qualities. Naturally the patent-right owner and the man with a theory came to the fore, and the merits of various devices and systems were enthusiastically presented, after which the committee made a tour over the country, inspecting the methods employed in New York, Chicago, St. Louis and other places. For some reason the original committee could not agree to report upon a definite scheme, whereupon a special committee composed of officials identified with the local city government was empowered to carry on the investigation, and on its report Boston has entered into a contract with a concern for building a reduction form of apparatus, for the construction of a plant equal to the requirements of Boston.

The nature of the process (Merz system, said to be entirely inodorous, and by which all microbes contained in the material treated are destroyed) is the subjecting of the mass in closed digesters to the action of steam under pressure. While the digesters are being charged, the vapors arising from the mass are drawn into pipes and discharged into the furnace under the boiler where they are destroyed by the heat together with any microbes they may contain. The material during treatment is constantly stirred. Escaping odors are condensed in water and discharged through pipes into sewers. Oily matters are melted and are then saved for industrial purposes. The mass when sufficiently treated in the

digesters, is subjected to powerful pressure which squeezes out liquid portions. Subsequent drying in special dryers completes the process, results of which will be watched with interest by other cities. The process is claimed to completely rob the material of all offensive or dangerous properties, and the paper quoted expresses the opinion that "while the crematory method finds many supporters the action of the Boston investigators will probably put a quietus on this method."

Garbage Cremation in America.

THOSE who desire to form a correct judgment on the opinion expressed in the previous review by the editor of the *Progressive Age*, should read concurrently a paper written by Messrs. Charles T. Bayless of Louisville, Ky., and Arthur E. Merkel, of New York city, and published in *Engineering News*, wherein an enumeration of methods and appliances for garbage cremation beginning with what the writers incorrectly state to be the first cremator ever used in the United States, and ending with the Engle Crematory at the World's Columbian Exposition at Chicago, is presented, occupying about four pages of the publication named.

The first attempt made to cremate garbage in this country is stated by the authors to have been by use of an apparatus designed and built for the purpose by Lieut. H. T. Reilly, U. S. A. The place was Governor's Island in New York harbor. It was applied to the daily disposal of the garbage of the island, which varied from 10 to 30 cubic feet. Of this apparatus it is said that it is of interest not only from the fact that it was the pioneer of garbage cremation in America, but also because it embodied certain features essential to success in incinerating this kind of material. Its construction and operation are described as follows: It consisted essentially of a chamber $4 \times 5 \times 3$ feet lined with fire-brick, and divided into three spaces by two gratings composed of $\frac{3}{4}$-inch round iron bars, with 1-inch openings between them, and the necessary doors, grate bars (surface 6 square feet) and ash pit. The gratings were for the purpose of supporting the garbage so the heat could get through and dry it, and prevent it from stopping the draft, or putting out the fire.

Its operation was commenced by making a coal fire, and putting the garbage in on the right side to dry; the next day's garbage was put in on the left side, and the dry garbage then raked over the fire. By placing the garbage on the right and left alternately, dry garbage is supplied and the fire kept burning. There was a 50-feet chimney, and but slight odor came from it. This crematory was self-sustaining, no fuel otherwise than garbage being necessary, and of course was very economical in the cost of running it.

A small garbage crematory was also erected in 1885 in Allegheny City, Pa. Natural gas was the fuel employed. In the same year a crematory was built in Montreal, Canada, which is said to have been a modification of what has been called the "English Destructor." Two years later a similar cremator was erected in Chicago, which after trial proved a failure.

The first Engle cremator was erected in Des Moines, Iowa, in 1886; but the large furnace of this kind at Des Moines was not put in operation till 1887. The same year the Forrestal furnace was built in Milwaukee, Wis. In 1887, the Rider furnace was put in operation in Pittsburgh, Pa. In 1888, the Glasgow plant was adopted in Detroit, and the Merz system was adopted in Buffalo.

In a foot-note the editor of *Engineering News* states that the above enumeration is not complete; and also that the first furnace used was not on Governor's Island as stated, quoting from a paper read by Col. W. F. Morse in 1892, a statement that "for 16 years the United States Government has destroyed the wastes of military posts in a special furnace." The editor also corrects another statement of the authors, that the cremators above enumerated are "the principal ones in operation in this country," stating that when the paper was written there were some others in use, and that "at present, a number of new ones are in process of development, or are actually in use." It is also added to this correction, that "the Simonin system deserves mention as well as the Merz, but

neither employs cremation." A description of the Rider furnace at Pittsburgh, Pa., of the Merz system, and of the Engle Crematory at the Columbian Exposition follows, with numerous interesting data, that will well repay the reading of those who wish to inform themselves upon the subject. It may be remarked in concluding this review, that a system for disposal of garbage other than that now in use in the city of New York, is said to have been proposed to the city authorities during the past summer, and to have been favorably regarded.

Incandescent Gas Lighting.

IN a paper by Mr. R. S. Galloway of Edinburgh, at the annual meeting of the North British Association of Gas Managers, and printed in the *Journal of Gas Lighting*, the system of what is called incandescent gas-lighting, introduced by Dr. Carl Auer Von Welsbach, it is explained that the point of excellence in this system is the fact that the moment the gas is lighted the light-giving body, or mantle, as it is technically called, "is raised to its highest incandescence and this without any forced pressure or alteration of existing fittings." It will be understood that the light emitted with this system is therefore not directly emitted from the gas, but from this incandescent mantle. The gas flame is converted into a heating, rather than a luminous flame, and this heats the mantle to a temperature at which it affords a powerful and beautiful white light. The system, besides giving a far better light, also consumes less gas for a given amount of illumination than is needed with ordinary gas-burners. This system in its early and imperfect stage of development was first exhibited in New York a number of years ago. With reference to the improvements made in the system, Mr. Galloway says:

It may be well to disabuse the public mind that this present system of Welsbach incandescent gas lighting which has been more prominently brought before you during the past months, is the same as was introduced some seven years ago. It is the same, and it is not the same. True, the idea is the same—viz., raising a filament to a high temperature, or to incandescence through the agency of a flame from an atmospheric burner. But every part of the lamp (mantle included), as already stated, has been improved, till now the whole is almost perfection. The burner is now made to cause practically complete combustion; is more ornamental than formerly; and can be fitted with a regulator, which counteracts any variation of pressure.

Advantages over the incandescent electric lamp are claimed. The present "C" Welsbach mantles are claimed to give from 18 to 20 candle-power per foot of gas consumed per hour; or, to use the words of the author "an incandescent 'C' burner, burning 50 per cent. less gas, gives over three times the light" of a similar sized burner without the Welsbach mantle. An ordinary electric lamp gives 16-candle-power nominally. Therefore, more than three electric lamps would be required to give results of one incandescent 'C' gas-burner." Or, putting this in still another way, "for a given sum of money an ordinary 5-feet per hour gas-jet will give three times the light, and an incandescent gas-burner will give over 12 times the light of an incandescent electric lamp." The points made are summed up as follows:

(1) The light is practically one-eighth the cost of electric light. (2) It is from one-tenth to one-fifth the cost of other systems of gas lighting. (3) Its hygienic advantages are not obtainable with any other system of gas lighting. (4) It can easily and readily be attached to existing fittings. (5) It is suitable for all inside and outside lighting.

Exactly what the mantles are made of is not named; only the vague statement is vouchsafed that "its principal ingredients are certain minerals occurring in high northern latitudes." Dr. Auer is quoted in this connection as stating with reference to these minerals that "they have to change their form many hundred times before they are obtained in the pure state in which they can find application on the incandescent material." This statement, coming from a scientific man seems rather queer, and appears designed to conceal a secret rather than to impart any

real information. The mantles, as prepared, whatever they consist of, are claimed to last through 1200 hours of actual service.

IN discussing "The question of Low Priced Gas," Mr. Allen R. Foote takes as his text in *Light, Heat and Power* a quotation from the address of Mr. E. H. Jenkins, President of the Western Gas Association. "I am a firm believer in the policy of selling the best quality of gas at the lowest price consistent with earning a fair dividend on the investment made." Mr. Jenkins having quoted a number of Western cities as recent examples of this policy, and having stated that these examples will be watched with interest by the gas companies of the country, Mr. Foote takes the ground that Mr. Jenkins made a mistake in the selection of some, if not all, of his examples. Mr. Foote considers that low priced gas produced "as the result of a war between gas companies and municipal authorities, or between competing gas companies is not produced in accordance with a sound, philosophical and scientific policy." He thinks that the attempt to furnish low priced gas under these conditions leads to fraud or robbery. At the same time he admits that "low-priced gas, philosophically and scientifically produced, is an acquisition of the first importance to the inhabitants of any municipality. As a moral and economic agent it is second to none known to our civilization. Every decrease in price infinitely widens the use of this agent for the production of light, heat and power." His contention is that in the effort to furnish low-priced gas under the stress of competition, abuses are certain to creep in.

THE same number of this excellent magazine contained an excellent article on "The Relief Holder System in Water Gas Manufacture," written by Mr. F. H. Shelton. It is the purpose of this article to show "that the flow of gas through a works making water gas and using a relief holder is more uniform than the flow through the average coal gas works; that under such circumstances the flow may be made practically absolutely constant, and that for reasons of economy, safety, accuracy and uniformity of product, a relief holder should be invariably used whenever possible in the manufacture of water gas." What is meant by a relief holder is then defined, and its proper function and use are discussed at length.

MR. EDWARD M. HARRIS, writing in the *American Gas Light Journal* for Aug. 27, on "Electric Lighting versus Gas," asserts that there is a "strong feeling of dissatisfaction with and want of confidence in the electric light in Great Britain, not only among its consumers in the chief cities and towns, but through the entire country, whether receiving their current from electric lighting companies or from corporation installations paid for by funds taken from the poor old money chest of the public." He avers that in the latter case taxpayers are revolting against the system, especially those who are non-users of the electric lights. The writer charges against electric lighting systems their cost, inconstancy, detriment to vision, imperfections for display, and danger to property and life. He says these defects are so serious in England, that a large number of people have concluded to "let well enough alone," and continue the use of gas. He adds that the illuminating power of the electric light has been greatly exaggerated.

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*24219. Presidential Address of James M'Gilchrist (J G L–July 31.) 2800 w.

*24220. The Practical Results of Enriching Gas by the Peebles Process at the Alloa Gas-Works. A. Yuill (J G L–July 31.) 2500 w.

*24221. Further Developments of the Peebles Process. W. Young (J G L–July 31.) 3200 w.

*24222. Incandescent Gas Lighting. R. S. Galloway (J G L–July 31.) 1800 w.

24286. The Andrew Gas Engines. Ill. Herman Poole (A G L J–Aug. 13) 1800 w.

*24301. Construction and Working of Regenerator Settings of Retorts. Ill. W. R. Chester, with Discussion (G W–July 28.) 11000 w.

We supply copies of these articles. See introductory.

*24329. The Question of Low-Priced Gas. Allen R. Foote (L H P-July.) 4000 w.

*24330. Some Reasons Why Philadelphia Should Retain and Not Sell Its Gas-Works. William Wallace Goodwin (L H P-July.) 4000 w.

*24331. A Gas Company's Method of Working Tar. Irvin Butterworth (L H P-July.) 600 w.

*24332. The Relief Holder System in Water Gas Manufacture. F. H. Shelton (L H P-July.) 2500 w.

*24333. The Municipal Ownership of Works. Arthur Kitson (L H P-July.) 1900 w.

*24335. Natural Gas. Joseph D. Weeks (L H P-July.) 2500 w.

*24336. Which—High Candle Power or Low? (L H P-July.) 4500 w.

24339. The Industry of Gas in the United States of North America. W. Oechelhaeuser (P A-Aug. 15.) 12500 w.

*24370. Discussion of A. Yuill's Paper on "The Practical Results of Enriching Coal Gas from Oils by the Peebles Process at Alloa Gas-Works." (J G L-Aug. 7.) 5200 w.

*24551. Discussion of William Young's Paper on "Further Developments of the Peebles Process of Enriching Coal Gas from Oils." (J G L-Aug. 14.) 6400 w.

*24552. Discussion of Mr. Galloway's Paper on "Incandescent Gas Lighting" (J G L-Aug. 14.) 2000 w.

24591. Gas Engine in France. What the Best Practice Now Is, with Editorial (B J C-Aug. 25.) 1900 w.

24593. Electric Lighting vs. Gas. Edward M. Harris (A G L J-Aug. 27.) 1400 w.

*24614. On the Manufacture of Fire-Clay Gas Retorts, and the Advantage of Having Standard Sizes. P. Hurll, with Discussion (G W-Aug. 18.) 3000 w.

*24615. A 50-feet Diameter Gasholder. Ill. W. B. Featherstone (G W-Aug. 18.) 4500 w.

*24657. The Prepayment Meter System Growing in Popularity (J G L-Aug. 21.) 2000 w.

*24753. New Evidence as to the Atomic Weight of Carbon. J. A. Wauklyn, with Discussion (G W-Aug. 25.) 1500 w.

*24894. The Lighting of Paris. (Extract.) Henri Maréchal (J G L-Aug. 28.) 2000 w.

Streets and Pavements.

24480. Massachusetts Highways and the State. Editorial (R G-Aug. 17.) 1500 w.

*24840. Theoretical Properties of Asphalts. Dolphus Torrey (P-Sept.) 4200 w.

*24842. Oil Residuum in Asphaltic Paving Compositions. Samuel P. Sadtler and J. Edward Whitfield (P-Sept.) 2200 w.

Sewerage.

24381.—$1.50. A Concrete Sewer on Piles. Ill. Eugene Lentilhon, with Discussion (T C E-June.) 3500 w.

24676. Garbage Cremation in America. Ill. Charles T. Bayless (E N-Aug. 30.) 5800 w.

*24841. Diagrams for the Discharge of Circular Sewers. Ill. John W. Hill (P-Sept.) 600 w.

Water Supply.

24214. A Fountain on Every Corner—Denver, Col. (F W-Aug. 11.) 700 w.

†24224. Water Supply for Indian Towns. C. S. R. Palmer (I E-July 7.) 1100 w.

24387. The Comparative Cost of Mechanical Filters and Sand Filter Beds. Editorial (E N-Aug. 16.) 1300 w.

24388. The Relative Estimated Cost of Mechanical Filters and Sand Filter Beds.—Letters (E N-Aug. 16.) 5600 w.

*24619. Borehole Wells for Town Supply. Henry Davey (E-Aug. 17.) 2200 w.

24678. The Chemical Analysis of Public Water Supplies. Henry Leffmann (E N-Aug. 30.) 2300 w.

24679. Leavitt High-Duty Pumping Engine, Mystic Station, Boston Water-Works. Ill. (E N-Aug. 30.) 900 w.

*24746. Water Supply of Towns—Review of Book by W. K. Burton (A L-Aug. 24.) 3000 w.

24797. Filtration. James B. Rider (E R-Sept. 1.) 3500 w.

*24843. Report of Professor Winchell on the City Water Supply of Minneapolis (A B D-Aug.) 2800 w.

Miscellany.

24337. The Waste of Cities (P A-Aug. 15.) 1400 w.

24824. Public Holdings in Massachusetts (G & F-Sept. 5.) 1300 w.

24857. Public Lighting by Municipal Plants. Horatio A. Foster (E E N Y-Sept. 5.) 5000 w.

Serials.

14839. Water Purification in America. Ill. (E N-Began Aug. 3, 1893—14 parts to date—15 cts. each).

22758. The Chicago Drainage Canal. Ill. (R R-Began June 9—12 parts to date—15 cts. each).

23641. Details of Rural Water Supply (B-Began July 7—8 parts to date—30 cts. each).

24213. The Filter of the Water Supply of the City of Lawrence and Its Results. Hiram F Mills (F W-Began Aug. 11—1 part to date—15 cts).

24218. Fifty Years of Gas Manufacture.—A Retrospect (J G L-Began July 31—Ended Aug. 7—2 parts—30 cts. each).

24258. Manchester Main Drainage Works. (Abstract.) William Thomas Olive (I C T-Began Aug. 3—Ended Aug. 17—3 parts—30 cts. each).

24338. Gas Engines. David Solomons (P A-Began Aug. 15—2 parts to date— 15 cts. each).

24751. The Gas Manager Abroad. Thomas Newbigging (G W-Began Aug. 25—2 parts to date—30 cts. each).

We supply copies of these articles. See introductory.

RAILROADING

A Year's Railway Progress and Its Lessons.

FROM the English Blue Book recently issued by the commercial and statistical department of the Board of Trade, containing railway returns for the whole Kingdom for the year 1893, *Industries and Iron* has compiled some very interesting figures. It appears from these statistics that the railway mileage in the United Kingdom has increased two and one-half times since 1854, the date at which systematic records were commenced. At the end of 1893 there were 20,646 miles of railway in operation, 9374 miles of which were single and 11,272 miles double track. The increase of mileage during the year was a little over 300 miles. The total authorized capital invested in railways was £1,090,898,780. This amount is stated to be nearly twice the amount of the English national debt. The average cost per mile of English railways is given as £47,047. The paper quoted admits that this is a very high average, and later on in the article hints that "no doubt questions might be asked as to the amount of the total capital actually used in the construction, and how much in compensating landlords and paying lawyers at extravagant rates." In this connection it may be instructive to recall the reasons assigned for high cost of English railways as presented by Mr. William M. Acworth, on page 26, Vol. V, of THE ENGINEERING MAGAZINE. Mr. Acworth assigns, among other good reasons, the pressure of public opinion upon railway companies which compels them to expend large sums in construction as an assurance to the public that the roads will be perfectly safe in their operation. He regards this pressure of public opinion as the most potent influence of all the reasons for expensive construction assigned by him.

The article under review states that 873,177,052 passengers were carried during the year 1893, exclusive of season-ticket holders, or, "to put it more exactly, that number of railway journeys was made by the general public." The gross revenue of the railways for the year was £35,849,449, or 44.46 per cent. of the total receipts. The freight traffic consisted of 207,836,308 tons of minerals and 85,454,493 tons of general merchandise transported over a distance of 141,781,026 miles, yielding a revenue of £40,994,637, or 50.84 per cent. of the entire receipts. Rents and other sources yielded an additional revenue of £3,787,806, thus making the total revenue from all sources £80,631,872. It cost £45,695,119 to earn this revenue, leaving a net revenue of £34,936,773, which amounts to about 3.61 per cent. on the invested capital. The tendency to decreased percentage of profits in railroading is noted. A steady decrease since 1889 has been in progress. The percentage in 1893 was less than in any previous year notwithstanding the mileage exceeds that of any previous year. It is also stated that the working expenses of the year 1893 are the largest recorded. The smallest recorded expenses have been 47 per cent. of the invested capital. This has happened in three different years, to-wit: 1860, 1864 and 1871. It is asserted that since 1871 the expenses have always exceeded 50 per cent. During the year 30,000,000 first-class, 60,000,000 second-class, and 782,000,000 third-class passengers were carried.

An inspection of the returns indeed shows a tendency not only for the second class travel to disappear but also the first class, and, indeed in the not very distant future it almost looks as if there would be only one class. The third class carriages are now as comfortable in every way on many of the lines as were the first class a few years ago, so that what people pay for is not so much increased comfort as a little more select company, and in these democratic days this distinction will tend to disappear.

The gradually decreasing return on the capital invested in railways is noted. The

reasons for this tendency are assigned as "the growing competition, the demands of the public for improved accommodation and more rapid communication, and of the workers for higher wages." It is also stated that the workers are demanding shorter hours, and that "as the result of the railway workers' organizations, the railway companies have been compelled to pay three millions more in wages in 1893 than they paid in 1890."

Railroad Companies and the People of the West.

THE results of legislation upon transportation, both on the part of individual states and of the general government of the United States, are considered in a well written article contributed by Mr. F. J. Goddard to *The Independent*, and reprinted in *The Railroad Gazette*. The spirit of antagonism to railroad companies on the part of the agricultural population of the western states is believed by this writer to be at present much less pronounced than it was a few years ago. Mr. Goddard thinks that the "almost constant public discussions of the railroad problem, so-called, during the past few years have had beneficial results in showing to each side the faults of the other, and that from these discussions a better understanding of the questions involved is being developed.

"The general intent of most of these laws, (enacted for regulating railroad traffic) is to prohibit unjust discrimination as between persons and localities, and to provide reasonable rates of transportation for all." While these ends are considered as right, and desirable for both parties, certain difficulties have arisen, the chief of which are the result of impracticable means to accomplish the end sought.

The interstate commerce law as it now exists furnishes an illustration of this statement. What the public desired was a law which would provide reasonable rates of transportation and guarantee the public against unjust discrimination as between persons and localities, and this was undoubtedly its intent. And yet some of the sections of this law seem, in practice, to interfere with and prevent the accomplishment of this result.

Sections 4 and 5 of the present law are cited as of this character. Of section 4 the author remarks:

This would appear to state a sound principle, and yet in practice and by reason of commercial, geographical and economic conditions which surround its operation, its enforcement results in either producing discriminations or destroying competition, neither of which were intended.

Of Section 5, commonly called the "non-pooling clause," he says:

This section prohibits a legitimate means, which was previously used by the railroad companies, to prevent unjust discrimination and illegitimate competition. By illegitimate competition, I refer to that condition which results in railroad companies transporting persons or property at such rates or fares as will not properly compensate them for the services performed. "The laborer is worthy of his hire," is as true of railroads as it is of mechanics, merchants or ministers; and our laws should seek to regulate all the industries and activities of the people in such a manner as will place them upon a just equality, thus stimulating them to perform their greatest use. This has been called the era of speculation, which considered in its ordinary commercial sense, I interpret to mean the obtaining of valuable consideration without at the same time rendering an equivalent. In this sense it is the curse of the age, and our laws at least should be so framed as to discountenance such operations in every form, whether indulged in by railroad companies, commercial bodies or individuals.

The article concludes with remarks upon the railway legislation of the states, which are regarded as being in general "especially in the west, most liberal," but which on this account "have resulted in causing the construction of thousands of miles of railroad for which there was no legitimate public demand, but which were built solely for speculative purposes."

Mr. Goddard thinks this "foolish waste of money should be regarded as a public burden which it must sooner or later become." He thinks much could be learned by American legislators from a study of the railroad legislation in European countries.

We have much to learn from the experience of

other countries in railroad legislation, both as to laws concerning their construction as well as those governing their operations. Several, if not all, of the European countries have fully recognized the necessity of providing means whereby railroad rates and fares can be changed only by general consent. They thus secure stability, which is essential to the best interests of every legitimate commercial enterprise.

The laws of European countries also provide against building needless roads for speculative purposes. Government operation of railroads is disapproved, and the writer thinks this scheme is not so popular now as it has been. He thinks it only a question of time when the fourth and fifth sections of the interstate commerce law will be repealed or modified, and hopes the time may soon come "when use will be recognized as the true end of all earthly activities."

A Historical Sketch of Railroading Signalling.

THE *Railroad Gazette* is reprinting in serial form with copious illustrations the lecture delivered by Mr. Arthur H. Johnson before the Lawrence Scientific school, Harvard University, Cambridge, Mass., in May of the present year. As might be expected, the series covers a broad field of invention wherein a vast amount of thought and effort has been wasted, but which has evolved finally the advanced systems of improved signalling devices that characterize modern railway practice, and without which or their equivalents, it would have been impossible to have safely employed train speeds even much less than those now common on all great railways.

In looking over these old records one is impressed by the number of devices which we recognize in the many signal patents taken out from time to time by inexperienced inventors. It would take a long time to briefly describe the great number of different devices that have been proposed for signalling, but I will not dismiss the subject without mentioning a signal proposed about 1845, which revolved quickly to indicate a clear track, slowly to indicate caution and was stopped to indicate danger or stop. Hand signals for use in starting, stopping, backing, etc., were introduced at an early day and have changed very little in principle as used to-day.

The date of the introduction of detonators or torpedo signals is fixed at about 1841. That the date cannot be named more precisely shows how stealthily important innovations sometimes creep into practice in these days of many innovations. Of fog signalling the author states many attempts have been made during the past fifty years to do fog signalling with "automatic machines, working in conjunction with the fixed signals. No such machine has been widely introduced, owing partly to its being bad in principle to depend upon the action of mechanism which is only called into practical use under exceptional conditions, except when, like fire engines, the machine can have constant supervision. In England, where there is much fog, the trackmen have standing orders to report for duty as fog-signal men in case of fog. Each man has his allotted position at a home or distant signal. He takes a supply of detonators and places two of them on the rail or removes them in accordance with the indications of the fixed signal which he serves."

The author lays down, as one of the first principles in signalling, "that the normal position of all signals must be the danger position; and that "should any part of the mechanism fail, the signal should at once fly to the danger position." The logic of the proposition, apparent to all conversant with the subject, may not be so clear to others, but will become so if they will consider the fact that in the operation of any system which necessitates the use of warning signals to make it reasonably safe, any fault occurring in the signalling apparatus, that renders it wholly or practically inoperative, at once introduces an element of danger, which it is the function of the apparatus to indicate. The entire series comprises reviews of the history, principles, and practice, of signalling. Nearly or quite every kind of signalling apparatus or system of signalling of importance is separately described with illustrations that will make the subject clear even to readers who have not had any previous knowledge of the subject.

A Great Intercontinental Railway.

THE Report of the Intercontinental Railway Commission is now about completed, and *Transport* makes it the theme for an interesting article under the title, "A Great Intercontinental Railway." This journal says the advance sheets indicate that the report "will be a marvelously interesting work from every standpoint. It will give important information concerning railway possibilities never before offered to the world, and will trace a continuous railway route extending from Mexico down to Argentina, a distance of 4500 linear miles. It will fairly bristle with newly ascertained facts and practical statistics touching all the republics of South America; it will be illumined by a profusion of photographs of life and scenery along the whole route, and will be still further enriched by a vast quantity of charts and maps—topographical, geographical, and geological—of the regions traversed, thus combining the features of a fresh book of travel and adventure with the more substantial features of a technical report. But above all, the report will demonstrate the entire feasibility of constructing an intercontinental railway, and will show conclusively that no insurmountable engineering difficulties stand in the way of such a momentous undertaking."

The article goes on to give a history of the commission, which first met and was organized in Washington under the auspices of the State Department in December, 1890. The scope of the work is then stated. The organization of the three different surveying corps of engineers, and the apportionment of their work into divisions is described. Corps No. 1, under Lieutenant M. M. Macomb, U. S. A., commenced work at Ayutla, on the Northern frontier of Guatemala, and a continuous line of survey was run from that point south-east, through the republics of Guatemala, Salvador, Honduras, Nicaragua, and Costa Rica, by way of Retalhulea, and other intervening places to the Rio Savegre.

Corps No. 2, under Engineer W. F. Shunk, of Harrisburg, Pa., started in at Quito and surveyed northward till the party reached the Rio Savegre, thus connecting their work with that of Corps No. 1.

The third corps, under Mr. W. D. Kelly, C. E., of Philadelphia, Pa., also started in at Quito and worked southward to Cuzco. The length of the entire line surveyed was 4234 miles.

INDEX TO LEADING ARTICLES.

*24255. The London, Chatham and Dover Railway Company and Its Continental Services (E-Aug. 3.) 1600 w.

24265. Cleaning of Passenger Cars. A. M. Waitt (R C J-Aug.) 1000 w.

24279. What Is the Use of Car Steps? Editorial (R A-Aug. 10.) 800 w.

24280. The Illinois Central's Suburban Train Service (R A-Aug. 10.) 800 w.

24281. Trial by Jury—Speculative Suits; Extortionate Verdicts Against Corporations. Address of A. J. Ricks (R A-Aug. 10.) 3600 w.

24295. A Great Inter-Continental Railway (Tr-Aug. 3.) 1100 w.

*24297. Glasgow Central Underground Railway. Ill. (R W-Aug.) 4200 w.

*24306. La Guaira and Caracas Railway. E. H. A. Heinke (R P L-Aug.) 1500 w.

*24307. Conversion of Gage on the Bengal-Nagpur Railway. George Moyle (R P L-Aug.) 3300 w.

*24309. A Railway Crisis. G. A. Sekon R P L-Aug.) 2000 w.

*24312. Temperature as Affecting Railway Axles. Thomas Andrews (R P L-Aug.) 2500 w.

24321. Can Interference with the Movement of Commerce Be Prevented? From Harper's Weekly (R R-Aug. 11.) 1500 w.

24323. The Railways of Australia. Daniel W. Maratta (R R-Aug. 11.) 3000 w.

24324. The American Railway Union and Its Methods. Address of J. A. Musterd (R R-Aug. 11.) 2500 w.

24325. Cliff Railways. George Croydon Marks (R R-Aug. 11.) 2000 w.

24326. Legislative Management of Railways. Editorial (R R-Aug. 11) 800 w

24355. New Air Brake Practice. J. Heon Crosman (A M-Aug. 16.) 700 w.

*24404. Private Ownership of Rolling Stock. —The Fife Judgment (Ry T-Aug. 11.) 1100 w.

We supply copies of these articles. See introductory.

24453. The New Union Station at Boston. Ill. (R A-Aug. 17.) 600 w.

24478. Steel Rails. (Extracts.) P. H. Dudley (R G-Aug. 17.) 3000 w.

24479. The Effect of Valve Travel on Efficiency. Editorial (R G-Aug. 17.) 1400 w.

24491. Railroad Companies and the People of the West. F. J. Goddard in the Independent (R R-Aug. 18.) 1300 w.

24493. Concrete Work on the Calanas-Tharsis Railway, Spain. Ill. Archibald Miles Anderson (R R-Aug. 18.) 1400 w.

24507. A Vast Army (M S P-Aug. 18.) 600 w.

24529. The New Union Station at St. Louis. Ill. (R G-Aug. 24.) 1800 w.

*24568. Railroading in America. Ill. (Eng L-Aug. 17.) 3700 w.

*24582. Character Sketch. Eugene V. Debs: President of the American Railway Union. Ill. (R of R-Aug.) 6500 w.

24586. Railway Companies and Their Employés. Ossian D. Ashley (R A-Aug. 24.) 3800 w.

24587. Sequel of the Strike (R A-Aug. 24) 1600 w.

24598. Far Away Sweden and Its Railway (B I S-Aug. 25.) 600 w.

*24616. The Opening of the West Highland Railway (Tr-Aug. 17.) 4000 w.

24622. Railroad Traffic Associations. Edward T. Jeffery (R R-Aug. 25.) 1800 w.

24623. "Blacklisting." Editorial (R R-Aug. 25.) 800 w.

*24662. Chinese Railways and Chinese Ironworks. Ill. G. P. Snelus (E Rev-Aug. 20. 1200 w.

*24672. Reminiscences on Locomotive Smoke-Boxes, Exhaust Nozzles and Stacks. Ill. W. H. Thomas (L E-Sept.) 2600 w.

*24673. Broken Stay-Bolts.—Cause and Effect. Ill. Charles E. Fourness (L E-Sept.) 1100 w.

24680. To Prevent Swindling in Railroad Management, with Editorial (R G-Aug. 31.) 3000 w.

24715. Southern Railroads of To-day. D. Allen Willey (M R-Aug. 31.) 2400 w.

*24770. Railway Construction in Japan and China (Tr-Aug. 24.) 1600 w.

*24771. The Bechuanaland Railway (Tr-Aug. 24.) 1100 w.

*24810. High Speed on Railways. W. H. Weston (N C B-Sept.) 1600 w.

*24811. Freight Cars. J. F. Boucher (N C B-Sept.) 1000 w.

24815. The Strike at Pullman. Statements of George M. Pullman and Thomas H. Wickes (R R-Sept. 1.) 10000 w.

24870. The San Ellero-Saltino Rack-Railway, with Telfener Rack. Ill. Julian Edward Caccia (E N-Sept. 6.) 700 w.

24872. The Interstate Commerce Statistician's Sixth Annual Report (E N-Sept. 6.) 1900 w.

24875. Cross Sections of Railway Road-Beds. Ill. (E N-Sept. 6.) 2600 w.

24891. Notes on German Railroad Practice.—Train Service. E. M. Herr (R G-Sept. 7.) 1700 w.

24893. Night Schools for Railroad Boys. Editorial (R G-Sept. 7.) 2800 w.

24903. Vanderbilt Railroads South.—What It Means for Southern Advancement (M R-Sept. 7.) 1400 w.

24910. The Relation of the Road Master to Block Signaling and Interlocking (R A-Sept. 7.) 4000 w.

*24912. Early British Locomotives. Ill. (E-Aug. 31.) 1500 w.

Serials.

15496. Railroad Coppersmithing. Ill. (L E-Began Sept., 1893—10 parts to date—30 cts. each).

17826. Evolution of the Air Brake. Ill. Paul Synnestvedt (R E M-Began Dec.—9 parts to date—15 cts. each).

18435. Painting a Railway Passenger Car. A. Ashmun Kelly (R E M-Began Jan.—7 parts to date—15 cts. each).

21747. Steam Tramway Locomotives. Ill. H. Conradi (R W-Began April—Ended Aug.—5 parts—30 cts. each).

22639. A Master Car Builders' Reminiscences. John Kirby (R C J-Began June—2 parts to date—15 cts. each).

23719. The Early Railway Routes to Scotland. G. A. Sekon (R P L-Began July—2 parts to date—30 cts. each).

23887. The West Highland Railway. Ill. (E-Began July 20—4 parts to date—30 cts. each).

24266. Brakes and Brake Calculations (R C J-Began Aug.—1 part to date—15 cts).

24477. A Historical Sketch of Railroad Signaling. Ill. Arthur H. Johnson (R G-Began Aug. 17—2 parts to date—30 cts. each).

24621. Rules and Instructions for the Guidance of Railway Agents (R R-Began Aug. 25—2 parts to date—15 cts. each).

24660. The Compounding of Locomotives. Ill. A. H. Tyler (E Rev-Began Aug. 20—1 part to date—30 cts).

24741. The Relative Efficiency of Air Compressors and Locomotive Air Brake Pumps for Shop Use (R E M-Began Sept.—1 part to date—15 cts).

24809. Car Shop Economy. James F. Hobart (N C B-Began Sept.—1 part to date—30 cts).

24817. Recent Turntable Practice. Ill. (R R-Began Sept. 1—1 part to date—15 cts).

24896. The Conversion of Meter Gauge to Indian Standard (5'6") Gauge on the Bengal-Nagpur Railway. Ill. G. Moyle (I E-Began Aug. 4—1 part to date—45 cts).

24938. Passenger Train Services in 1894 (Tr-Began Aug. 31—1 part to date—30 cts).

We supply copies of these articles. See introductory.

STREET RAILWAYS*

The Paris Cable Railway.

THE *Iron and Steel Trades Journal*, in describing the road named in the title, gives an interesting account of its construction and operation. The cost of the road was $240,000. As bearing upon the tricks and manners of slots in cable roads, it is stated that "the interval between the time of the practical completion of the works in November, 1890, and the unrestricted opening for traffic in August, 1891, was partly employed in making experiments with the running of from one to four cars at speeds varying from 3.35 miles per hour to the intended regulation working speed of 6.7 miles per hour, and in carrying out various modifications in the position and design of the various guide pulleys which were erected experimentally in the first instance.

As it might be supposed that an investigation of the methods employed in San Francisco, Chicago and London would have enabled the constructors to meet the difficulties encountered without all this experiment, it is explained that "this line differed from either of the foregoing in so far as that, with the exception of the crossing places, it was a single line and with a very sinuous course, owing to the direction and narrowness of the streets passed through; therefore the arrangement of the guide rollers, or sheaves, was complex, and had to be considerably modified before the final completion.

The following details are given with reference to the narrowness of the slots:

On the second December, 1890, after several days' frost, it was found that at several points the gripper slot which originally was intended to be $\frac{7}{8}$ inch wide, had become reduced to $\frac{5}{8}$ inch, and, as the frost continued so this narrowing became more general. On investigation, the principal causes of this seemed to have been expansion of the paved portions on each side of the track, this action being transmitted from the track rails to the irons forming the slot, the expansion of the sub-soil, frozen to a great depth, exercising an exceptional thrust upon the cable channel walls, and lastly, the contraction of the iron frames carrying the track rails and slot irons.

The remedy was to increase the slot to a width of $1\frac{1}{8}$ inches, easing the ties of the frames connecting the track rails with the slot irons and laying a band of asphalt $1\frac{1}{4}$ inches to 2 inches in thickness between the track rails and the outer strip of paving on each side, this material forming a cushion which absorbed the effects of expansion of the roadway. The remedy was effective, and no narrowing of the slot of any importance has since taken place. The remainder of the article comprises a complete description of the cable driving machinery and the mechanism which carries the cable.

The Boynton Bicycle Railway.

The *Electrical Review* (London) makes some interesting editorial comments on the Boynton Bicycle Railway in contrast with Behr's suspended bar system, and points of similarity as well as of difference are indicated.

While the Boynton idea is considered as being much on similar lines to that of Behr, it differs in this respect, that while Behr's cars run upon a single rail elevated in the air, the cars being suspended from it, in the Boynton system the train runs upon a rail laid on the ground as in the ordinary way, except that it is a single rail, a guide rail being supported in the air and horizontal wheels acting to steady the car or cars upon the supporting rail at the bottom. It is pointed out that a difficulty comes in with reference to the operation of the system on sharp curves and at high speeds. In discussing this point the writer remarks that although "there is a small Boynton line at Coney Island and another at Bellport, Long Island, this proves nothing more than the possibility of the idea at moderate speeds. But we are

* Through an oversight two pages of reviews omitted from this department this month.

not invited to a moderate speed. The suspension idea was for 100 miles an hour. The bicycle train is to go at 150 miles velocity, and it is as such that we must treat it. Probably the overhead guide wheels would make an intolerable rattle, but that is out of the question for the present. The idea is admirable for a straight piece of line, or for those having slight curves permitting so small an inclination from the vertical that it would not be serious; and as an electrically worked railway, this seems to possess peculiarly suitable features."

As regards speeds, it is thought that the road might be mechanically suitable for moderate speeds, but that the structural expense renders it doubtful as a commercial enterprise. "Looked at as an ordinary light railway, the weak point is the expense of the superstructure." In conclusion the question is asked, "Why, if 150 miles an hour is to be attained on the Boynton line, was this speed not secured in America previous to the asking of support from the guileless and gullible Britisher?"

In Long Island there is truly nominal length enough wherein to start and stop a high flyer, but we have really not room enough to do it here, and in all seriousness we must state that, however mechanically pleasing the Boynton idea may be, if considered on sober lines, it is somewhat of an impertinence to put forward half digested schemes of this sort. We are so plainly given to understand that there will be curves, and yet nothing is said as to how passengers fare when the patented inclination does not agree with the curve. Perhaps there will be patented passengers.

INDEX TO LEADING ARTICLES.

*24207. Evolution of the Electric Railway. Irving Hale (E Mag-Oct.) 3000 w.

24267. Electrolytic Corrosion: Legal Status of the Question. R. D. Fisher (S R G-Aug. 11.) 1800 w.

24268. Gas Motors for Street Railways. Frank H. Mason (S R G-Aug. 11.) 1700 w.

24368. The Reno Underground Rapid Transit System. Ill. (E E N Y-Aug. 15.) 900 w.

*24441. The Boynton Bicycle Railroad (E R L-Aug. 10.) 2000 w.

*24481. Electric Power on the Chicago City Railway. Ill. Cable Moved by Electricity (S R R-Aug.) 2300 w.

*24482. Electric Car Heating. Ill. W. S. Hadaway, Jr. (S R R-Aug.) 1200 w.

*24483. The Barmen Electric Rack Railway. Ill. (S R R-Aug.) 800 w.

*24484. Leavenworth's Line. Ill. (S R R-Aug.) 1800 w.

*24485. Ex-President Harrison on the Indianapolis Franchise (S R R-Aug.) 4000 w.

*24487. The Three Wire Trolley System at Bangor, Me. (S R R-Aug.) 800 w.

24488. First Electric Railway in Russia. Ill. (S R G-Aug. 18.) 500 w.

*24577. Motors for Electric Traction Work. Ill. (I & I-Aug. 17.) 2300 w.

*24579. The Douglas and Laxey Electric Tramway. Ill. (I & I-Aug. 17.) 1900 w.

*24603. The Belleville (Paris) Cable Railway. Maurice Widmer (I & S-Aug. 18.) 1500 w.

24638. Lighting of Electric Railway Cars. (E R N Y-Aug. 29.) 700 w.

24681. Frictional Resistance on Cable Roads. (R G-Aug. 31.) 500 w.

†24701. The Use of Storage Batteries in the Trolley Railway Plant at Zurich, Switzerland. Ill. (S R J-Sept.) 2000 w.

†24702. The Manchester (England) Tramways. Ill. (S R J-Sept.) 1500 w.

†24703. The Hoosick Falls Railway. Ill. J. H. Vail (S R J-Sept.) 1600 w.

†24705. Ascertaining the Speed of Trolley Cars. James F. Hobart (S R J-Sept.) 1600 w.

†24706. The Street Railway System of Montreal, Canada. Ill. (S R J-Sept.) 2000 w.

†24707. New Switching Facilities—Chicago City Railway Company. Ill. (S R J-Sept.) 800 w.

24812. Devices for Keeping the Trolley Wheel on the Wire. Ill. (S R G-Sept. 1.) 700 w.

24871. The Use of T-Rails for Street Railway Tracks. Ill. (E. N.-Sept. 6.) 1000 w.

Serials.

21260. Electric Traction. C. H. Wilkinson (E P-Began April—4 parts to date—30 cts. each).

23713. Emergency and Wreck Wagon Systems. Ill. (S R R-Began July—2 parts to date—30 cts. each).

23909. Notes on Electric Tramways in the United States and Canada. H. D. Wilkinson (E E L-Began July 20—Ended Aug. 3—3 parts—30 cts. each).

24308. The Florence and Fiesole Electric Railway. Charles Scheibner (R P L-Began Aug.—1 part to date—30 cts).

24442. Facts and Figures Concerning Some Continental Electric Tramways (E E L-Began Aug. 10—Ended Aug. 24—2 parts—30 cts. each).

24659. An Electric Railway System for London. Ill J. H. Greathead (E Rev-Began Aug. 20—1 part to date—30 cts).

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SCIENTIFIC MISCELLANY

Arctic Temperatures and Explorations.

ONTARIO has an Association of Land Surveyors, which recently held its annual meeting. The proceedings of such an association might seem to laymen as not promising much of general and popular interest; but in this case a proposition was made that will attract attention the world over. This proposition was no less than that the Canadian surveyors would undertake to run a meridian to the North Pole, if the government would authorize such an enterprise; and a committee was thereupon appointed to consider and report upon the subject.

In the *Popular Science Monthly* for September, Mr. Stuart Jenkins has contributed an article dealing with the possibility of such a survey, which contribution is one of the most interesting miscellaneous scientific papers that has appeared for the month.

He says the proposition "is not so wild as it may seem," and thinks "it will prove interesting to the public to show what Canadian surveyors have already done and compare their methods with those of Arctic explorers."

Mr. Jenkins speaks of the surveyors' methods from personal experience, he having been an instrument man with a survey party in the Canadian North-West, of which Mr. G. B. Abrey, D. L. S., was the chief. There were fourteen men in the party, all told, and this party remained "out under canvas" for twelve months,—June 1882–1883. The work necessitated the moving of the camp daily. "Winter commenced on the 1st of November, when snow fell to the depth of two feet and remained." The outfit is described as consisting of "four ten-ounce duck tents, in three of which were small sheet iron box stoves, and in the fourth, the cook's tent, a sheet iron cookstove. In the winter the food was pork, beans, dried apples, and bread, with tea and sugar; to which may be added eight hundred pounds of fresh beef, and the flesh of one elk or wapiti, and one jumping deer. The party shot prairie chickens when possible. Mr. Jenkins describes the clothing of the party:

"For clothing I wore woolen underclothing, such as I now wear in the city of Toronto, a flannel shirt, and, over these caribou breeches with long woolen stockings drawn over them, a chamois leather vest, and a small single breasted tweed coat such as is worn in the city before overcoats become necessary in the fall. My feet were clothed with duffle and moccasins, and my head with a double knitted, Hudson Bay tuque, which can be pulled right down over the ears. A pair of common woolen mitts completed my outfit. At no time during the winter did I wear either overcoat or muffler. Indeed, neither the one nor the other was to be found in the camp. Mr. Abrey's dress was nearly the counterpart of mine, and the men wore woolen clothing altogether. At night Mr. Abrey and I used two pairs of Hudson Bay blankets and two buffalo skins each. The blankets we sewed up into bags and put one buffalo skin beneath and one over us. We slept on folding stretchers which was, of course, not as warm as sleeping on the ground. The men's sleeping outfits consisted of blankets only."

The fuel of the party was dry poplar sticks which Mr. Jenkins states make a good hot fire, but one which cannot be kept more than half an hour without renewal. The party had a standard spirit thermometer which registered down to —62° F. and had been tested by the Toronto observatory. Illustrating the extreme cold to which the party was subjected during the second week in January Mr. Jenkins states that "the cook one morning came bustling in with the breakfast, his shirt sleeves as usual rolled up above his elbows, announcing that the bottom had dropped out of the thermometer." Mr. Jenkins found that in fact the spirit had all run down into the bulb and that therefore the temperature was at some point below —62° F. He says "the news spread through the camp, and the men came crowding round

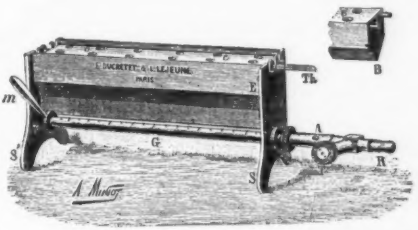
to see the unusual phenomenon. One man ventured the opinion that we had got to the North Pole by mistake, but they looked upon it more as a joke than anything else, and were perfectly satisfied because it meant a holiday," the rule being that the men were not to go on the line when the temperature was less than —30° F. Going out from the camp that day on snow shoes Mr. Jenkins says "although it was cold at starting I was warm enough before I got back." The next night the temperature reached —58° F. and the third night —61° F.

"Now, according to all precedent we should have spent those three nights cowering with quaking hearts over the stove and using up the cook's fat to make the fires burn. As a matter of fact we went to bed as usual and slept without any fires at all. Not only that, but we suffered no discomfort. The only unpleasant thing about it was the turning out of one's blanket in the morning to light the fire and that I admit *was* cold but still nothing that a strong man could not stand with equanimity. But what will be thought when I state that during those three days of extreme cold Mr. and Mrs. Abrey were on their way from Battleford to Fort Pitt, *and slept out without any tent, and without keeping up a fire through the night?* If a Canadian surveyor's wife could do this, a Canadian surveyor can get to the North Pole. Mr. Jenkins regards the cause of drowsiness which is usually supposed to be produced by extreme cold, as rather attributable to exhaustion than to exposure to low temperature. On this point he says he has more than once 'walked fifty miles on snow shoes and never felt anything of the kind,' but he 'made it a rule to stop every four hours and draw some tea, and eat a good square meal.' He says 'when this practice is followed, it is astonishing how far a man can go without excessive fatigue.'"

The remainder of the article comprises a sketch of a plan for reaching the North Pole which in spite of probable criticism Mr. Jenkins ventures to present, assuming at the start that expense is simply no consideration whatever, and under the belief that if a feasible scheme is proposed "there is enough enterprise, private and governmental, among Anglo-Saxons, to carry it through, even if it cost a million."

The Measurement of Fusing Point Temperatures.

AN instrument for the determination of fusing points illustrated in the accompanying engraving was submitted to the chemical society of Paris in 1887 and has been described in *Industries and Iron* from which also the accompanying cut has been reproduced. Only as much of the article as is necessary to give an understanding of the operation of the instrument will be here reviewed, although the difficulties met with in the accurate determination of fusing points are made the subject of some interesting remarks. It is evident that the determination of melting points must present difficulties, since different observers, all admitted to be able experimenters, have sometimes differed in their determinations for the same material as much as 10° C.



This apparatus of Maquenne is designed to indicate the exact fusing points of materials with the application of second and third corrective terms to the readings taken by observation.

The apparatus consists essentially of a prismatic block B of red copper, drilled longitudinally a little below its upper surface in order to form a chamber wherein to place the thermometer Th., the latter giving very exact readings, and an exact indication of the temperature of the metal throughout. This block is supported by two vertical copper plates which protect the gas flame of the gas burner G from drafts coming in endwise. The whole is mounted on supports S. A gas-cock T regulates the flow of gas to the burner through R. Copper being one of the best conductors of heat, it is possible to heat it to 400° C., so uniformly that no correction is needed. Substances

to be tested are placed in the small cavities *c* made in the upper surface of the copper block. The jets of gas issuing from the burner are controlled by the handle *m*, and by means of this and the regulating cock T a very sensitive adjustment of the heating power of the jets between temperatures below 100° C., up to the maximum temperature above named can be obtained. Of course substances which at any temperature react chemically upon copper cannot be tested in this instrument.

Maxim's Flying Machine.

AMONG the many articles short and long concerning the trial of Maxim's Flying Machine, there are few if any that convey so good an idea of the nature of the machine and the real significance of the results attained at the trial, as that published by *The Engineer* (London). The fact that the machine did actually fly through the air, and had to be held to keep it from flying away, as attested by numerous witnesses of high repute in the scientific and engineering world, must make the examiner in the U. S. Patent Office who rejected Mr. Maxim's application for a patent, on the ground that it was inoperative, feel rather cheap. This sapient individual not only refused to allow Mr. Maxim's application for a patent, but refused to admit any evidence that the machine is operative, unless a working model that would actually fly should be supplied to the office. As a model of the small size required by the U. S. patent office could not, by any amount of ingenuity, be made operative, the effect of the examiner's action, if not overruled on appeal (as it is certain to be), precludes Mr. Maxim from obtaining a patent. This certainly is a singular position for an inventor like Mr. Maxim to be placed in,—a man whose fame as a successful inventor is world-wide, and who is the very antipode of perpetual motion visionaries, in dealing with whom, the U. S. patent office has had to require models, because, only by the fact that their models obstinately refuse to work are the examiners generally able to demonstrate the inoperative character of such alleged inventions.

Some time, and at no distant day, the pluck, energy, skill, persistence, and lavish expenditure of money that have characterized the Maxim experiments, together with the enormous difficulties he has attacked and surmounted, will form the most brilliant chapter in the history of artificial flight. The patent office examiner who said the machine could not fly, and who refused to listen to such evidence as Mr. Maxim can bring to prove that it can fly, might possibly be rendered more useful to the office than he is at present by dispensing with his services.

The machine did fly. The engineer thus describes the experiment:

> We shall briefly glance over the occurrences of July 31 last, on which occasion the soaring tendency of the machine became so great as to overcome all the obstacles which were designed to retain it near the ground, and Mr. Maxim found himself in a somewhat similar position to that of Frankenstein when overpowered by the monster which he himself had fabricated and endowed with life. This is what happened: The machine had traveled some 1000 feet, the latter 550 feet of which it had flown, a fact which is clearly proved by the impressions made on the inverted guard rails. It appears that suddenly the lifting effort became so great that the frame work carrying the after retaining wheels became distorted to such a degree that the wheels failed of their office, and the afterpart of the machine became free; the forepart however, continuing to hold the machine down, but not for long, as the wobbling which ensued rendered steering impossible, and the machine got out of line with the track; the left hand front wheel also got free and the machine charged one of the timber supports carrying the right-hand guard rail, tore up the rail, which is simply a 9 inch by 3 inch plank, and did very great damage to its own framework. The ride was in this way brought to a sudden stop, and it will be several months before it can be renewed. The total weight of the machine, including 600 lbs. of water, 200 lbs. of naphtha and three men was about 8000 lbs.

The article then gives an illustrated description of the machine and details of its construction. These show in a pronounced manner the wonderful wealth of mechanical resource possessed by the gifted inventor.

What Mr. Maxim has done is, so to speak, to make a bird that does not know how to fly. We believe that the safe use of such a machine will always depend on the skill of the driver. Because we put on skates we do not expect to be able to skate right away. No more can we expect Mr. Maxim to be able to control this machine efficiently until he has had years of practice. In the same way there are birds who fly well and birds who fly badly. This bird has only just been hatched. Let us hope that Mr. Maxim will not come to grief, "Icarus like," before he is fully fledged.

No more interesting article than this has appeared in the technical literature of the month, as is well indicated by the fact that it has either been reprinted in full, or liberally quoted by an unusual number of publications.

A very graphic pen-picture of an experiment with the Maxim flying machine has been drawn by a reporter of the *Pall Mall Budget*. This description has been reprinted in the *Scientific American*, with an illustration of the scene that is presumably a fancy sketch, since it bears the imprint of the last named publication. In describing trials of new machines the average daily newspaper reporter, while apt to get tangled in attempted scientific explanations and go astray in the applicaton of technical terms perceives aspects that escape more acute scientific observers absorbed in the contemplation of the operation of devices, and intent upon observing accordance with or violations of mechanical principles in their construction. The reporter sees with the popular eye, and describes what he sees, or, at least what he thinks he sees,—sometimes what he does not see at all. In general, however, such reports present a more vivid impression of the scene as a whole, than could be expected from a technical writer. The following is an account as given by the reporter:

There was a hissing and spluttering as some pumps got to work, and then, presently, the port propeller began to revolve with a rapidly increasing whirr-r, and the cry went up to "look out." In a few seconds whirr-r-r went the starboard propeller also The platform on which we stood rocked and quivered with vibration. A hurricane seemed to spring up, laying the hay flat far and wide, and scattering like a whirlwind the shavings in the workshop twenty yards away. Every one grabbed his hat with one hand, and clung for dear life with the other to a rail. Suddenly, when the tornado had reached its height, and the whole machine was shaking and straining at its anchor like a greyhound in the leash, a shrill whistle gave the order to "let go," and the huge structure bounded forward across the meadows with a smooth sailing motion, at a rate increasing up to forty miles an hour.

As the end of the track came in view a look of horror set in. There was nothing apparently but a quick-set hedge to arrest our wild career. A rope was stretched across the path. We crash through it. Then another; then another, and finally we come to rest in the easiest, gracefullest manner imaginable, within a few feet of what looked like perdition. Then we all laughed. It was a most delicious sensation, wiping out forever such tender memories as switchbacks, toboggans, and the seductive water chute. It was unique, in fact, and unlike anything that the world has ever seen; for the occurrence just described represents the crude residual impressions of a first trip over the rails on Mr. Maxim's giant flying machine.

The inventor beamed pleasantly as he noted the effect for he had a distinguished company on board. There were Lord Kelvin and Lord Rayleigh, Sir Douglas Galton, Professor Vernon Boys, Sir Guilford Molesworth, Earl Russell, Professor Pettigrew, of Edinburgh, and the science representative of the *Pall Mall Budget*. After the first trip there was a unanimous demand for a second, and the huge structure, weighing but some 7000 pounds in all, was pushed back along the rails on which it runs to the starting point, where steam was got up once more and the performance repeated.

INDEX TO LEADING ARTICLES.

*24234. Geology and Scenery in Ireland. Ill. (N-Aug. 2.) 600 w.

*24236. Pleistocene Climatic Changes. Warren Upham (G M-Aug.) 4300 w.

*24238. Jurassic Ammonites: On the Genus Cymbites (Neumayr.) S. S. Buckman (G M-Aug.) 2000 w.

*24239. Twenty Years' Work at the Younger Red Rocks. A. Irving (G M-Aug.) 2000 w.

*24241. The Primitive Boulders of the York-

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shire Coast and Their Lessons. Henry H. Howarth (G M-Aug.) 1800 w.

24242. The Home of Minnehaha. Ill. A. B. Choate (G R-Aug.) 1000 w.

24244. The Advantages Gained by Sprinkling Country Roads. A. Greeninger (G R-Aug.) 2200 w.

*24256. Flying by Steam (E-Aug. 3.) 900 w.

24284. Louisburg. A. D. Abbott (From N. Y. Evening Post) (A A-Aug. 11.) 900 w.

24287. The Achievements and Aims of Physical Chemistry. J. E. Trevor (A G L J-Aug. 13) 3000 w.

24327. Business Training. B. F. Spalding (A S-Aug. 11.) 2500 w.

24328. New Statues in New York (G & F-Aug. 15.) 1600 w.

24343 The Effect of Extreme Temperatures Upon Matter. Nelson W. Perry (E N Y-Aug. 15.) 2200 w.

24350. American Association for the Advancement of Science. William Henry Hale (E W-Aug. 18.) 1500 w.

24361. Rope Bridges and Their Military Applications. Ill. (Sc A S-Aug. 18) 2200 w.

†24371. A Visit to Corea. A. H. Savage-Landor (F R-Aug.) 3300 w.

†24374. The War-Chests of Europe. Heinrich Geffcken (N C-Aug.) 7000 w.

24384. The Resistance of Materials Under Impact. Mansfield Merriman (E N-Aug. 16.) 6200 w.

†24399. Arctic Temperatures and Explorations. Stuart Jenkins (P S M-Sept.) 5000 w.

†24400. The New Mineralogy. G. Perry Grimsley (P S M-Sept.) 2200 w.

†24401. Science as a Means of Human Culture. Floyd Davis (P S M-Sept.) 4500 w.

*24417. The Maxim Flying Machine. Ill. (E-Aug. 10.) 1400 w.

*24418. The Temples of Philæ. Ill. (E-Aug. 10.) 500 w.

*24425. Maxim's Flying Machine. Ill. (Eng L-Aug. 10.) 2700 w.

*24432 Aeration of the Present Day. (Extract.) Ill. O. Chanute (I & I-Aug. 10.) 1900 w.

*24435. Japan, China and Corea. Editorial (I & I-Aug. 10.) 1200 w.

*24443. Presidential Address of the Marquis of Salisbury Before the British Association (E E L-Aug. 10.) 6600 w.

*24444. Address of A. W. Rücker to the Mathematical and Physical Section of the British Association (E E L-Aug. 10.) 8000 w.

*24445. Address of A. B. W. Kennedy to the Mechanical Science Section of the British Association (E E L-Aug. 10.) 6500 w.

*24447. Mr. Maxim's Triumph and Disaster: the Ascent of, and Accident to His Flying Machine (Inv-Aug. 11.) 3000 w.

*24450. An Oxford School of Chemists. Address of H. B. Dixon (N-Aug. 9) 8500 w.

*24551. Address of L. Fletcher. Geology (N-Aug. 9.) 10000 w.

*24499. The Hydro-Geology of the Upper Mississippi Valley and of some of the Adjoining Territory. Ill. Daniel W. Mead (J A E S-July.) 10800 w.

24501.—75 cts. A Classification of Economic Geological Deposits, Based on Origin and Original Structure W. O. Crosby (T Q-April.) 9400 w.

24511. The Brooklyn Meeting of the American Association for the Advancement of Science (Sc A-Aug. 25.) 2800 w.

24513. A Trial of Maxim's Flying Machine. Ill. (Sc A-Aug. 25.) 1800 w.

24517. Naples—Street Scenes, the Museum, a Half Day at Pompeii. Ill. A. D. (Sc A S-Aug. 25.) 3600 w.

*24523. The Mound-Builders. W. H. Withrow (Ch-Sept.) 2100 w.

24530. Our New Army Rifle (A & N J-Aug. 25.) 2000 w.

*24558. The Maxim Flying Machine.—A Prodigy and Museum of Invention. Ill. (Inv-Aug. 18.) 550 w.

*24562. The British Association. I. Address by I. Bayley Balfour.—Biology. II. Address by W. J. L. Wharton.—Geography (N-Aug. 16.) 11500 w.

*24563. Address by W. H. Flower.—Anthropology (N-Aug. 16.) 8500 w.

†24633. China and Japan in Korea. I. Augustine Heard. II. Durham White Stevens. III. Howard Martin (N A R-Sept.) 8500 w.

†24634. Our Little War with China.—Some Hitherto Unwritten History. Peirce Crosby (N A R-Sept.) 2200 w.

†24635. The Development of Aërial Navigation. Hiram S. Maxim (N A R-Sept.) 3500 w.

24648. Progress of the Excavation at Delphi (Sc A S-Sept. 1.) 2200 w.

24649. Niagara and the Great Lakes (Sc A-Sept. 1.) 1600 w.

24650. Some Peculiarities of Water. J. J. Stewart (Sc A-Sept. 1.) 3000 w.

*24658 Engineers of To-Day—and Yesterday. Jeremiah Head. Ill. (E Rev-Aug. 20.) 1000 w.

24667. The Thermal Relations of Air and Water. Frank Richards (A M-Aug. 30.) 1700 w.

24677. The Armor Plate Scandal. Editorial (E N-Aug. 30.) 2000 w.

24681. Engineering Education. Abstracts of papers by C. Frank Allen, F. O. Marvin, Palmer C. Ricketts, George F. Swain, R. H. Thurston and Others (R G-Aug. 31.) 8000 w.

24685 —75 cts. The National Guard.—What It is and its Use. James M. Rice (J M S I-Sept.) 8200 w.

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†24709. The Constitution of the Zeolites F. W. Clarke (A J S-Sept.) 1800 w.

†24710. Notes on the Tertiary and Later History of the Island of Cuba. Robert T. Hill (A J S-Sept.) 6500 w.

†24711. On the Occurrence of Leadhillite in Missouri and Its Chemical Composition. L. V. Pirsson and H. L. Wells (A J S-Sept.) 2700 w.

†24712. On the Magnitude of the Solar System. William Harkness (A J S-Sept.) 8300 w.

†24713. On the Nitrogen Content of California Bitumen. S. F. Peckham (A J S-Sept.) 2000 w.

†24714. Description of Tertiary Artiodactyls. Ill. O. C. Marsh (A J S-Sept.) 4800 w.

*24716. On the Iodine Value of Sunlight in the High Alps. S. Rideal (I & I-Aug. 24.) 450 w.

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*24763. Dr. Flinders Petrie's Excavations at Koptos, Egypt. Ill. (B-Aug. 25.) 3500 w.

*24772. The "New Gas." Editorial (E R L-Aug. 24.) 1300 w.

*24794. The Pneumatic Dynamite Guns. Ill. (A E R J-Sept.) 3400 w.

24825. Cold Storage. M. B. C. (G & F-Sept. 5.) 1700 w.

24827. The Soldiers' and Sailors' Monument, Cleveland, O. Ill. (MI N-Sept.) 1300 w.

†24848. Cladodus? Magnificus, a New Selachian. Ill. E. W. Claypole (A G-Sept.) 1100 w.

†24849. The Neobrara Chalk. Samuel Calvin (A G-Sept.) 7500 w.

†24850. Summary of Facts Proving the Cambrian Age of the White Limestones of Sussex County, New Jersey. Ill. Frank L. Mason (A G-Sept.) 2500 w.

†24851. The Elk Horn Creek Area of St. Peter Sandstone in Northwestern Illinois. Ill. Oscar H. Hershey (A G-Sept.) 3400 w.

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*24895. A New Ten Candle Lamp for Use in Photometry. A. Vernon Harcourt (J G L-Aug. 28.) 900 w.

*24922. The Navigable Balloon at the Antwerp Exhibition. Ill. (Eng L-Aug. 31.) 900 w.

*24929. Color Gauges for Carbon Testing. Walter G. McMillan (I C T-Aug. 31.) 4800 w,

*24934. Who Really Invented Cord te? Mr. Nobel's Further Appeal: Mr. Hiram Maxim's Claim to the Invention (Inv-Sept. 1.) 1800 w.

*24964. The Measurement of Fusing Point Temperature. Ill. (I & I—Aug. 31.) 800 w.

Serials.

20214. A General Review of Existing Artillery. Gaston Moch (J M S I-Began March—4 parts to date—75 cts. each).

21763. Engineering Practice and Education. Gaetano Lanza (J F I-Began May—5 parts to date—45 cts. each).

22848. Physical Units Magnus Maclean (E E L-Began June 8—7 parts to date—30 cts. each).

23406. Notes on Russian Geology. W. F. Hume (G M-Began July—Ended Aug.—2 parts—30 cts. each).

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24462. Graphic Statics. Ill. W. W. F. Pullen (P Eng-Began Aug. 10—2 parts to date—30 cts. each).

24600. China and Japan (I C B-Began Aug. 17—Ended Aug. 24—2 parts—30 cts. each).

24692. Turrets in the Forts on the Line of the Meuse. Lansing H. Beach (J M S I-Began Sept.—1 part to date—75 cts).

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NEW BOOKS OF THE MONTH

ALTERNATING CURRENT WIRING AND DISTRIBUTION. By William LeRoy Emmett, E. E. New York: *The Electrical Engineer*. [Cloth. 12mo. 76 pp. $1.]

IN a discussion in the British Institution of Electrical Engineers not many months ago, Mr. Kapp remarked that an impression which seemed generally prevalent, that alternating motors were still in the experimental stage, and were not to be relied on for practical work, was due to the fact that it was the fashion for the English electrical journals to cry down multiphase and alternating-current work. He sympathized, however, with the editors who, as he very justly remarked, "must find it very inconvenient to have to take up new subjects of study so as to be able to write intelligently about them." But the phenomena of alternating currents is a subject about which it is not so easy to write intelligently, or at all events clearly, even when one has himself sufficiently well mastered it. Mr. Emmett says in his preface that he has undertaken to explain the laws governing the distribution of alternating currents in such a manner as to make them intelligible to practical men, "without the expenditure of time necessary to the study of complete works on the subject." In this commendable undertaking we fear that he will be found to have met with only partial success. His elementary explanations are not only lacking in fullness, but, at times, are deficient in clearness as well,—faults obviously not due to any deficiency of knowledge on the part of the author, but rather to unskillfulness in presentation. For example, on page 9 it is stated that counter-electromotive forces "are caused by periodic variations in the current which cause changes in the magnetic flux through the circuit." Of course these forces may equally well be caused by variations which are not periodic, while the expression "magnetic flux through the circuit," though perfectly intelligible to the tyro, conveys no meaning whatever to the average student or practical man. Nor is the matter much helped by the attempted explanation in the next sentence, in which we are told that "the wires carrying the current are encircled by lines of magnetic force, and many of these lines generally pass through the circuit." Again, on page 8, in speaking of the tendency of alternating currents to seek the surface of the conductor, it is said: "It is easy to understand that this effect is relatively greater with large wires than small; also that it will be much greater with iron than with copper wires." Now the latter is an effect that is by no means "easy to understand," especially in the absence of the slightest attempt at elucidation.

Having briefly indicated what we conceive to be the principal fault of Mr. Emmett's work, we pass to the principal subject-matter, viz., a consideration of the practical aspects of alternating distribution. Of this portion of the work we feel justified in speaking in terms of high praise. It is seldom that so much really useful information is condensed into so small a space. Both the diphase and the triphase systems are discussed, and the characteristics of each pointed out. The conclusion of the author is, that for a system of town distribution, under the conditions which usually prevail in this country, secondary mains, preferably on the three-wire arrangement, with transformers installed in large units, will be found to give more satisfactory results as to economy and regulation than any other. The author gives the reasons for his opinion with sufficient fullness, and they seem to us to be conclusive. Such a system of secondary mains obviously becomes the more desirable in view of the modern tendency to make use of a single organization of distributing conductors for all classes of electric service.

In case a second edition of Mr. Emmett's

is called for, the nomenclature of the different phenomena of the alternating circuit might advantageously undergo some changes. The introduction of the term "reactance," under the sanction of the American Institute of Electrical Engineers, in lieu of "inductive," resistance happily renders it possible to dispense forevermore with that absurd phrase "ohmic" resistance, which, as the late George Prescott once wittily remarked, is as if one should speak of the "feetic" length or the "poundic" weight of a conducting wire. The book is neatly printed in clear, open type, and is illustrated with an abundance of diagrams. Altogether, it will be found a useful addition to the library of the electrical engineer.

FRANKLIN L. POPE.

THE ANIMAL AS A PRIME MOTOR, AND THE LAWS OF Energetics. By R. H. Thurston. New York: John Wiley & Sons.

THIS book, a monograph of 97 pages, gives in an introduction and in concise and comprehensive form, fundamental definitions and principles involved in the study and discussion of energy, the forces in which the author perceives the "characterizing attributes of the universe" (a profound generalization which has never been better expressed), mechanics and energetics, a discussion of the relations of matter, force and energy, laws of energetics, Newton's laws and the algebraic expression of energy-changes. The introduction then proceeds to the considerations of the object of all mechanism, sources and kinds of energy, and forms of motor, including the animal body, which latter he styles "a vital machine." Having thus led up to the theme of the work, the author enters a region of speculative thought of transcendent interest, namely, the vital processes by which motive power is supplied to animal mechanism. Of the nature of this power ignorance is frankly confessed; but the work clearly shows that the animal machine is not thermodynamic in the sense in which that word is now generally used, although the unknown vital processes produce heat, light and electricity as do heat engines when employed to generate these forces. In the present state of science, two facts only may be positively formulated with reference to vital processes. These are chemical changes in alimentary substances and in living tissue, and the result, in the production of the forces named, together with mechanical energy and a series of mental and emotional phenomena that appear to differ widely from any of the forces and phenomena dealt with in physical science. It is seen, however, that considered purely as a machine with relation to the development of mechanical energy and the performance of work, the vital animal structure is very much more efficient than any heat engine devised by human ingenuity. The book is one for thoughtful readers, and it is suggestive of immense possibilities to the human family when it is learned how to render the action of artificial motors more nearly like that of animal machines. Early in the book occurs the following pregnant sentence indicative of the trend of modern scientific thought. "We are gradually progressing towards the establishment of a law of persistence of all existence, whether of matter, of force and energy, or of organic vitality, and perhaps even to its extension until it includes soul and intellectual life."

LEICESTER ALLEN.

MICRO-ORGANISMS IN WATER: THEIR SIGNIFICANCE, Identification and Removal; together with an Account of the Bacteriological Methods Involved in their Investigation. Specially Designed for the use of those connected with the Sanitary Aspects of Water Supply. By Percy Frankland, Ph. D., B. Sc., F. R. S., etc., and Mrs. Percy Frankland, joint author of "Studies on Some New Micro-Organisms Obtained from Air." London and New York: Longmans, Green & Co. [Cloth, 8vo, xi.-532 p. With 2 plates and numerous diagrams.]

ALTHOUGH the literature of the bacteriology of water has grown to extensive proportions, notwithstanding the comparative newness of the science, publications on the subject are for the most part desultory and scattered through official reports, the transactions of societies and the scientific periodicals. The present work has the merit of bringing together in connected form accounts of the various and more important investigations in this branch of bacteriology, and should prove serviceable not only to students and investigators but also to those who, like engineers and health

officers, are practically concerned with the hygienic aspects of water supply. The methods of sterilization and preparation of culture media and the staining and microscopic examination of micro-organisms are described very thoroughly in the opening chapters. Other chapters are devoted to discussion of the bacterial contents of waters, the multiplication of micro-organisms, the detection of disease-breeding bacteria, the vitality of particular pathogenic bacteria in different waters, and the comparatively novel subject of the bacteriological action of light. An appendix contains a concise and systematic description of the more than 200 forms of micro-organisms hitherto found in water, which serves as a convenient reference for identifying the various species.

To sanitary and hydraulic engineers the most interesting portion of the book is that devoted to the purification of water for drinking purposes, in the water supply of cities and in domestic use. The hundred pages in chapter V on this head are most instructive, and, as would be anticipated from Professor Frankland's wide experience and high reputation as a specialist, the practical details are well and analytically worked out. Lessons are drawn from the experience of sand-filtration in the water supply of London, Berlin, Hamburg-Altona, Zurich and many other places, and from numerous experimental researches, including those of the Massachusetts board of health, which cannot fail to be of service to those operating or contemplating the installation of municipal water-purification works. The author lays down the following law, the applicability of which has been proved in practice to such a degree that predictions as to efficiency made on theoretical considerations are borne out with precision in actual practice:

> The factors which, in my opinion, are more especially calculated to influence the number of micro-organisms present in the distributed [filtered] water are the following:
>
> 1. Storage capacity for unfiltered water.
> 2. Thickness of *fine* sand through which filtration is carried on.
> 3. Rate of filtration.
> 4. Renewal of filter-beds.

The mere enunciation of these self-evident propositions does not convey an adequate idea of the manner in which they are elaborated as to details, for which the reader must be referred to the original text.

Throughout the book one is impressed with the radical revolution in scientific thought as to water contamination, putrefaction, and the origin and propagation of zymotic diseases, in so short a period as twenty-five years, or since the time when the authority of Liebig upheld the theory that organic substances in the act of decomposition are capable of causing the alteration and decay of other substances (as in fermentation), and beginning with the classic researches of Pasteur, Koch, and the new school of investigators, who have proved that living organisms are the cause of some, and possibly of all, zymotic diseases. In the case of two diseases, at least—Asiatic cholera and typhoid fever—the evidence may now be considered conclusive. This reversal of opinion and the establishment of the germ theory of disease (at any rate in part) have had a direct bearing upon systems of water purification. Whereas formerly the total organic contents of water was deemed the crucial point, now we look to the relative numbers of pathogenic bacteria. In other words, the work of the chemist, while by no means wholly displaced, must be supplemented by and made secondary to that of the microscopist and bacteriological specialist.

A. W., JR.

How to Become a Successful Electrician: The Studies to be Followed, Methods of Work, Fields of Operation and Ethics of the Profession. By T. O'Conor Sloane, Ph. D. Illustrated. New York: Norman W. Henley & Co. [12mo, Cloth, p. 8-190. $1.]

It is much to be regretted that in too many cases the latter-day publisher fails to grasp the important truth, that a book, like an individual, often fails to receive the recognition to which it is entitled by its intrinsic merits, by reason of its unattractive exterior. Any one who should chance to see this work lying upon a bookseller's counter, and should note its cheap looking binding, with the title stamped upon the cover in a tasteless

tangle of fancy lettering done in aluminum leaf and interspersed with a profusion of conventional zig-zags misrepresenting lightning, would naturally expect to find within nothing more useful or instructive than a collection of well-worn newspaper anecdotes of electrical "wizards," interspersed with platitudes more or less stale and unprofitable, and probably in nine cases out of ten, would not take the trouble even to open it. Every rule, however, is said to have exceptions, and the present work is most emphatically one of the exceptions. The world has hitherto had more than enough of treatises professing to point out to ambitious youth the short and easy road to that which is usually understood as "success,"—namely, material wealth. "He began poor and ended rich"—these few words usually tell the whole story. "It seems a hard thing to say"—says our author—"that honor and honesty are not in themselves favorable to the accumulation of a fortune." Yet in these latter days it cannot be denied that the truth of this axiom is being more and more forced upon our attention. If an engineer is to gain a high degree of professional success, money-getting must be incidental to his work, and only in a very minor sense a part of it, or he cannot render really valuable service to mankind. This view of the professional aim of the electrical engineer is strongly insisted upon by Mr. Sloane from first to last. He does not fail to point out that the professional man who seeks other success than wealth must, as a rule, content himself with other rewards than those which wealth can bring. He inculcates thoroughness, honesty, truthfulness, open-mindedness in all things. These, however, are but generalities. He points out how and by what means the ambitious youth who may perchance by untoward circumstances be prevented from entering upon a technical or collegiate course, may pursue a course of self-education which, with pluck and determination, will ultimately bring him to the desired goal. No attempt is made to disguise or underrate the difficulties of the task. Every chapter, indeed almost every sentence, is replete with useful knowledge, helpful suggestion and strong common-sense. The engineer, mechanic or student, electrical and otherwise, will find here in abundance mental stimulus judiciously intermingled with practical instruction. Seldom, indeed, have we met with a work of this kind in which there is so little to criticise and so much to commend.

FRANKLIN L. POPE.

A TEXT-BOOK ON ROOFS AND BRIDGES. PART III, Bridge Design. By Mansfield Merriman, professor of civil engineering in Lehigh university, and Henry S. Jacoby, associate professor of civil engineering in Cornell university. First edition; first thousand. New York: John Wiley & Sons. [Cloth, 8vo, viii-425 p. With numerous plates and diagrams. $5.]

THIS volume includes the design of plate girders, lattice-trusses and pin-connected bridges, together with the proportioning of details, in accordance with advanced modern practice and especially adapted to the use of students, though the practising engineer will find in it much useful material. As a text-book, the work is admirably analytical and progressive, the logical sequence of topics being carefully observed. The authors have had in view two leading motives—(1) the presentation of the subject rationally and as an application of the principles of mechanics; and (2) practically, as an illustration of modern economic structures. These two phases, so essential in the discussion, are necessarily blended, as they must be in practice to secure proper strength and greatest economy. Attention is confined to simple bridges, those resting on two supports, which class includes probably over ninety per cent. of all bridges and furnishes the best examples for the study of bridge design. While railroad bridges are given prominence, for illustration of other cases two highway structures for electric-car traffic are included, two chapters are devoted to roof trusses and another to elevated railways. In the typical examples selected the design is based on complete computations, as in a roof-truss, a plate-girder bridge, a pin-bridge and a riveted bridge. Somewhat heavier sections are derived than is usual in practice, though this is offset by the many examples of actual structures. The two first chapters contain a critical and

historical summary of the whole field, with references to the bibliography of the subject. The three chapters on shop methods will be welcomed as containing information not readily accessible in print. In addition to the work of the authors themselves, the utility of the volume is enhanced by contributions from several distinguished bridge designers, these additions coming in harmony with the main course of the discussion. Within the limits set by the authors, the work is very thorough and can be heartily commended for its ostensible purpose, that of a text book for students of civil engineering.

LABORATORY MANUAL OF PHYSICS AND APPLIED ELECTRICITY. Arranged and edited by Edward L. Nichols, Prof. of Physics in Cornell University. In two volumes. Vol. I. Junior Course in General Physics by Ernest Merritt and Frederick J. Rogers. New York: Macmillan and Co. [Cloth, 8vo., 294 p. Illustrated. $3.00.]

AS announced in the preface this book in its present form is the work chiefly of Assistant Professors George S. Moler, Ernest Merritt, and Frederick Bedell, of Instructors Frederick J. Rogers, Homer J. Hotchkiss, Charles P. Matthews, and of the editor.

The plan of the book, which as its title would indicate, is intended as a laboratory manual or textbook, has not been to provide a complete source of information for laboratory students but rather to furnish an outline which shall be filled in by the student by reference to larger works devoted more exclusively to the various special subjects which go to make up a complete course in physics and applied electricity.

The manual has been divided into two volumes and is designed for three classes of students differing from each other in experience, maturity and purpose, and the method of treatment has varied accordingly. This, the first volume, is intended for beginners, and therefore affords more specific directions, more demonstration than will the second volume. It also contains not infrequently elementary statements of principles, which will be omitted, it is announced in the second volume.

It is assumed in this volume that the student possesses some knowledge of analytical geometry and the calculus; also that he has completed a text book and lecture course in the principles of physics. The experiments have been divided into groups, an arrangement for which the editor assigns the following two reasons: 1. "On the one hand it serves to guide the practicant and the instructor in the selection of experiments," and 2, "it furthers the development of the system by making it easy to add or exclude material."

The book is printed in clear distinct type on heavy tinted paper and sufficiently illustrated with simple outline cuts which we are happy to say are not reproductions of cuts that have done service for a generation or more, but were evidently prepared for the occasion. Among these cuts are a number of candle power curves, and the book closes with tables of logarithms, natural series, cosines-tangents and cotangents following Bottomley's arrangement of four-figure mathematical tables.

A LABORATORY MANUAL OF PHYSICS AND APPLIED ELECTRICITY. Arranged and Edited by Edward L. Nichols, Professor of Physics in Cornell University. Vol. II, Senior Courses and Outlines of Advanced Work. By George S. Moler, Frederick Bedell, H. J. Hotchkiss, Chas. P. Matthews and the Editor. New York: Macmillan & Co. [Cloth, 8vo, 436 p. With Diagrams. $3.25.]

THE first volume of this manual consists of a laboratory course in general physics for beginners, with explicit directions as to the method of manipulation and the arrangement of results. Volume II is intended for students who have completed such a course and who are prepared to take up special work. Especial attention has been given to the needs of those in training to become electrical engineers. The several parts of this volume are divided as follow: Part I, experiments with direct-current apparatus; Part II, experiments with alternating currents; Part III, senior courses in heat and photometry; Part IV, outlines of advanced work in general physics.

ANNUAL REPORTS OF THE COMMITTEES OF COUNCIL, officers and departments of the city of Atlanta (Georgia), for the year ending December 31, 1893; showing the condition of municipal affairs. The Foote & Davies Co., Atlanta. 1894. [Leather, 8vo, 767 p. With cuts and maps.]

No more active or progressive a place could be named than Atlanta, and Atlanta justifies her reputation by the reports which she puts forth, and is fairly entitled to the advertisement entailed in them. The general business depression does not seem to have hit Atlanta very hard, the city's credit having been fully maintained and much public work having been carried on. The receipts and disbursements for the year may be stated at $2,000,000 each, in round numbers, and the expenditures appear to have been made in the direction of a liberal spirit of public improvement and government. If any adverse criticism is in order, the general tenor of the reports might be said to carry the impression that Atlanta is perhaps governed a little too carefully. Other cities may be lax in this respect—Atlanta certainly is not.

A DICTIONARY OF ELECTRICAL WORDS, TERMS AND PHRASES. By Edwin J. Houston, A. M., Ph. D. Third edition, with appendix, greatly enlarged. New York: The W. J. Johnston Co., Lt'd. [Cloth, 8vo, 669 double column p. 582 illustrations. $5.]

RECENT development in the electrical transmission of power has brought forward the subject of multiphased alternating currents, the rotary magnetic field and many phenomena new to industrial electricity; and in other branches the progress has been so rapid as to introduce a large number of new terms which are as yet scarcely to be met in electrical books. For this reason and because of the exhaustion of former editions, the appearance of this latest and third edition of Professor Houston's standard dictionary is timely. The additions amount to about 20 per cent. and are intended to bring the work down to the year 1894. Among the new electrical words, terms and phrases introduced in the last two years and incorporated in the present dictionary are included the results of the work of the World's Fair international electrical congress and of the committee on units and standards of the American institute of electrical engineers, with also proposed nomenclature from less authoritative sources, but which nevertheless is likely to be encountered by the reader. A careful system of cross-references has been adopted, to facilitate consultation. The dictionary is well gotten up typographically.

THE "PRACTICAL ENGINEER" POCKET-BOOK AND DIARY. Edited by W. H. Fowler, M. Inst. M. E. Manchester, England: Technical Publishing Co. [Roan 16mo. 229 p. 1*s.* 6*d.*]

HERE are given the tables, formulæ, and diagrams, and other information usually found in pocket-books intended for the mechanical engineer. It contains also a diary with spaces for each day in the year and closes with ruled blank pages for memoranda.

NEW TRADE CATALOGUES.

These catalogues may be had free of charge on application to the manufacturer.

SPECIAL mention is due, among the catalogues lately received in this office, to a mammoth "Illustrated Catalogue of Railway and Machinists' Tools and Supplies," issued by Manning, Maxwell & Moore, Nos. 111-113 Liberty street, New York, to indicate the unusually large line of products which they keep in stock or are able to supply on short notice. This is a substantially bound quarto volume (11×13 inches) of 1103 pages, embracing from two to a dozen well-executed engravings of tools or machines on every page, together with suitable descriptive matter and, in many cases, price lists. No fewer than thirteen three-column pages are devoted to an alphabetical index in the front part of the volume, embodying a marvelous range of mechanical aids throughout the entire alphabet, from "accumulators" to "zinc tubing." The appearance of the book is alone a strong guarantee of the high character of the house producing it.

The Tanite Company, Stroudsburg, Pa.=Catalogue of 1894. 47 p. [Facts relating to emery, and description and prices of Tanite emery wheels.]

Felt and Tarrant Manufacturing Company, Chicago.=Mechanical Arithmetic. 28 p. [Description of the Comptometer, with a statement of its advantages over mental work in making calculations.]

Westinghouse Electric Manufacturing Company, Pittsburgh.=Multipolar generators and motors. 16 p. [Illustrations and descriptions of apparatus from ¾ horse-power up.]

Singer Elevator Safety Stop Company, New York.=Unsafe Made Safe. 16 p. [Illustrations in detail of safety-stops for elevators.]

W. & L. E. Gurley, Troy, N. Y.=A Manual of the Principal Instruments used in American Engineering and Surveying. 372 p. [Fully illustrated with description and price-lists of engineering and surveying instruments.]

The Bridgeport Wood Finishing Company, New Milford, Conn.=General trade catalogue. 50 p. [Descriptive price-list of paints, finishes, etc., together with valuable suggestions as to their application.]

Indianapolis Terra-Cotta Company, Indianapolis, Ind.=General trade catalogue. [Carefully prepared publication with excellent illustrations of terra-cotta, tiles, etc., manufactured.]

The Raritan Hollow and Porous Brick Company, New York.=Fire-Proof Building Material. 85 p. [Handsomely gotten-up publication with illustrations and descriptive text of porous brick, terra-cotta, etc. Of interest to contractors and builders.]

William Whitlock, New York.=The National Chuck. 25 p. [Illustrated descriptive catalogue and price-list.]

Schaeffer & Budenberg, Brooklyn, N. Y.=General trade catalogue, 163-iii p. [Carefully compiled publication descriptive of pressure and vacuum gauges, injectors, and boiler appliances in general.]

John Maslin & Son, Jersey City, N. J.=Maslin Pump and Machine Works. 42 p. [Illustrated descriptive price list of hoisting engines, tubular boilers, steam drums, etc.]

The Ball & Wood Co., New York.=General catalogue. 36 p. [An artistic publication containing a treatise on the development of high-speed automatic cut-off engines.]

United States Mineral Wool Company, New York.=The Uses of Mineral Wool. 36 p. [Contains in concise form a description of the various uses to which mineral wool is especially adapted.]

D. Saunders' Sons, Yonkers, N. Y.=General catalogue. 90 p. [Illustrated descriptive publication of pipe and thread cutting machines, dies, pipe vises, etc.]

J. H. Lau & Co., New York.=General catalogue of sporting goods. 52 p. [Contains in addition to general sporting goods description of their Eagle blasting caps, which have been largely used in mining operations.]

Weston Engine Company, Painted Post, N. Y.=General catalogue. 27 p. [Contains full description, with illustrations, of the Weston automatic engine.]

Hilles and Jones Company, Wilmington, Del.=New and Improved Machine Tools. 32 p. [Contains illustrations of new machine tools for use of iron ship-yards, bridge works, etc., with special machines for working plate and shape iron.]

Dalton-Ingersoll Company, Boston.=Fine Sanitary Specialties. 323 p. [One of the handsomest and most comprehensive trade publications which has come under our notice, giving full description and price-list of various sanitary appliances. Of special interest to architects and builders.]

The New York Safety Steam Power Company, New York. Catalogue A, No. 24. 51 p. [Contains description of Safety steam engines, with points on lubrication and care of engines.]

The Heine Safety Boiler Company, St. Louis, Mo.="Helios." 161 p. [One of the handsomest trade publications which has come under our notice, setting forth the merits of the Safety boiler, with illustrations and descriptive matter. Will prove an excellent hand-book as it contains much valuable information.]

The De La Vergne Refrigerating Machine Company, New York.=Mechanical Refrigeration. 96 p. [Processes and apparatus of the company described, with full descriptive text and illustrations. Will prove of great value to those interested in mechanical refrigeration and ice-making.]

Wiley & Russel Manufacturing Co., Greenfield, Mass.=General Catalogue. 168 p. [Neat and comprehensive trade publication of patent screw cutting and other labor-saving machinery and tools.]

Standard Electric Company, Chicago, Ill.=The Standard System of Dynamo-Electric Machinery and Accessories. 87 p. [Giving in brief, with excellent illustrations, descriptions of Standard Electric appliances and dynamos, etc.]

Fred Bredel, C. E., New York.=Retort Houses and Retort Benches. 64 p. [Illustrations and descriptions of gas-retorts, of interest to those contemplating the erection or extension of gas-plants.]

W. R. Brixey, New York.=Kerite Insulated Wires and Cables. 47 p. [General descriptive price-list of telegraph, telephone, electric light and signal wires, with points on the use of Kerite insulation.]

The American Well Works, Aurora, Ill.=Illustrated trade catalogue. [Full descriptions of boring machinery, wind-mills, etc.]

Ball-Ball Company, Frankford, Philadelphia.=Drawing Instruments. 24 p. [Descriptive of drawing instruments manufactured.]

Pittsburgh Terra Cotta Lumber Co., Pittsburgh.=General trade catalogue. 26 p. [Descriptive of terra-cotta lumber as a fire-proofing material; of interest to builders, architects, etc.]

P. Blaisdell & Co., Worcester, Mass.=Catalogue of Machinists' tools. 24 p. [Contains full descriptions of upright drills, engine-lathes, planes, etc.]

The Battle Creek Machinery Company, Battle Creek, Mich.=The Marsh Steam Pump. 32 p. [Contains a treatise on steam-condensation, with illustrations of apparatus.]

J. A. Fay & Co., Cincinnati, Ohio.=Wood-Workers' Machinery Supplies. 87 p. [Descriptive price-list and telegraph code combined, compact and comprehensive.]